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ABSTRACT

The curriculum guide, which was prepared to serve as an aid to all teachers of business data processing, gives a complete outline for a high-school level course in both Common Business Oriented Language (COBOL) and Report Program Generator (RPG). Parts one and two of the guide together comprise an introduction to data processing, which deals with the elements of a data processing system, and to unit record equipment, which covers keypunch, wiring, printing, program control, and field and class selection. They contain 24 sections, each of which presents units of instruction, review questions, and laboratory problems. Part three, electronic data processing, contains 10 sections, variously organized, which cover flowcharting, and COBOL and RPG programing. Part four, teaching aids, contains unit record laboratory problems, practice sets dealing with a variety of computer programs, 57 overhead projector foils for both unit record and programing instruction, and a bibliography of books, IBM manuals, and recommended films. (JR)

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Business Data Processing

A TEACHER'S GUIDE

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

Business Education Service • Division of Vocational Education
State Department of Education • Richmond, Virginia 23216 • September 1974

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FOREWORD

Business data processing is a very real and important part of the business education offerings in many secondary schools today.

During the early stages of offering data processing on the secondary level many persons, including some business teachers, felt that this area was too sophisticated and that its institution into the curriculum was ill fated. We are proud that in Virginia these fears have been proven wrong. Businesses are now hiring our graduates in positions that were, a few years ago, reserved for college-trained persons. We feel that this success can be directly attributed to the fine job that the business teachers are doing.

In an effort to help business teachers in Virginia continue to do an outstanding job, this Curriculum Guide has been prepared to serve as an aid to all teachers of Business Data Processing.

We hope that it will be a useful guide in giving proper direction and emphasis to instruction. It is hoped that this guide will serve to motivate teachers in planning, executing, and evaluating the teaching and learning processes in business data processing.

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Superintendent of Public Instruction

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Director of Vocational Education

ACKNOWLEDGMENTS

This course of study for Business Data Processing is the climax of several years of planning and work by members of the staff of the Business Education Service, State Department of Education, Richmond, Virginia, teacher educators, and high school business teachers.

A special recognition is extended to Mr. Richard Robertson who was the principal author. Mr. Robertson was on the staff at Virginia Commonwealth University when this project was initiated but is now at J. Sargent Reynolds Community College.

Recognition is also extended to Carolyn Haynie of *George Marshall High School*, Fairfax and other committee members who attended the summer workshop at Madison College in 1970.

Special recognition is made of the leadership responsibilities assumed by Dr. A. Lee Hall of Virginia Commonwealth University who served as coordinator and editor. Without the splendid cooperation of all the aforementioned persons, this course of study could not have been made possible.

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INTRODUCTION

Because data processing programs vary greatly among high schools, every effort has been made to produce a Course of Study which could be adapted to as many as possible. For those schools offering courses using unit record equipment, there is a detailed section covering all aspects of wiring and operation. For those programs utilizing computers, two new sections have been added which outline the programming languages of COBOL (Common Business Oriented Language) and RPG (Report Program Generator).

It should be obvious that this Course of Study cannot serve as a complete teaching text, particularly for the programming sections. First, such total coverage would require at least four volumes. Second, there are enough variations in the programming languages among various computers that references to manufacturers' manuals are absolutely necessary anyway.

An attempt has been made to give a complete outline for a high school-level course in both COBOL and RPG. In addition to the outlines, there are narrative explanations arranged in basically the same order as the outlined items and in logical teaching sequence. Problem exercises (located in Division XXXV for Unit Record and Division XXXVI for Programming) are suggested at points where the student should have reached an understanding level sufficient to complete them satisfactorily. Wherever there are instruction variations peculiar to a variety of machines, the narrative section makes reference to the manufacturers' manuals. Overhead projector foils for both unit record and programming instruction are located in Division XXXVII. Transparencies may be made from these foils.

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PART I
INTRODUCTION TO DATA PROCESSING

DIVISION I: INTRODUCTION

A. Units of Instruction

1. Types of Data Processing

   a. Manual

   A manual data processing system was the first method of manipulating information. Data was processed by making marks in the sand, on a side of a tree or on a wall. Any type of handwritten material is a part of a manual system.

   b. Mechanical

   Typewriters, adding machines, calculators and bookkeeping machines are examples of mechanical methods of processing data. The devices were developed to process data with greater speed and accuracy.

   c. Electro-mechanical (unit record)

   Electro-mechanical equipment was first developed by Herman Hollerith and James Powers to process census data. Data is recorded in a card by a coded pattern of holes. These cards can then be processed by several machines designed to "read" the data stored in the card. Each machine operates independently of the other.

   d. Electronic (computer)

   The representation of data by electric impulses allows for fast, accurate processing of data. The computer also has greater flexibility than a unit record system. The unit record system is limited to cards and a printed report as input and output media. The computer allows a wide variety of input and output media. In addition, unlike unit record equipment, the equipment for the computer system is all under the control of one unit.

   (1) Digital computer—A computer which operates upon discrete (absolute) data by performing arithmetic and logical operations on the data. This type of computer is used in most business applications.

   (2) Analog computer—A computer that operates on data represented in the form of continuously variable physical quantities (e.g., voltage) by performing physical processes on the data. The analog computer usually approximates answers and consequently is used for scientific problems.

2. History

Over the history of mankind, man has realized the need for aids in the processing of data and has developed many devices for making these processes easier.

   a. Abacus

   The abacus was one of the earlier devices which was developed to aid in calculations. It is a device which uses ten beads on a string. There is one string for each digit position of the number, units, tens, hundredths, etc. The abacus was used mostly for addition and subtraction; however, multiplication and division could be done as well. (Multiplication is done by repeated addition. Division is executed by repetitive subtraction of the divisor from the dividend. The process is continued until the dividend is zero or less than the divisor. The number of subtractions determines the quotient.)

   b. Pascal's Adding Machine

   Blaise Pascal, of Paris, invented the first mechanical digital calculator in 1642. This early adding machine used a series of wheels which were turned to one of ten steps. There was one wheel for each position in the number. The first wheel represented the units position, the second

tens, etc. There was also a carry lever to operate the next higher digit wheel.

c. Joseph Marie Jacquard's Loom

In 1801, Joseph Marie Jacquard, a Frenchman, developed a textile loom that would weave intricate designs into cloth. This machine's new feature was its ability to follow a set of instructions which had been punched into cards.

d. Punched Card Equipment

The principle of the punched card was first applied to data processing by Dr. Herman Hollerith. Dr. Hollerith designed a machine in 1887 to help process census data. He was a statistician with the U. S. Census Bureau and realized the need to process faster the data which had been collected. This equipment was first used in the 1890 census. The previous 1880 census took seven and a half years to process with a population of 50 million. The 1890 census, through the use of Hollerith's equipment, took only two and one-half years to process although the population had grown to 63 million. Hollerith's first machine used paper strips similar to a player piano. These were soon found to be impractical and a standard size 3″ x 5″ card soon took its place. Hollerith organized the Tabulating Machine Company to develop and produce his machines. This company merged with another company and eventually became International Business Machines. IBM still uses the same code of punched holes and the same basic concepts of machine operation in its machines today.

e. James Powers' Punched Card Equipment

The Director of The United States Census Bureau, S. N. D. North, wanted equipment with still greater processing speed. Mr. North engaged James Powers to develop the equipment since Dr. Hollerith had left the Census Bureau. In 1908 Powers developed equipment which would process a 20 column card.

Powers formed the Powers Accounting Machine Company in 1911. The company grew and merged several times with other organizations and is now Univac.

f. Computer Concept

Another important individual in the development of modern data processing was Charles Babbage. Babbage attempted to build a machine capable of computing mathematical tables automatically. He managed to complete a model of this machine, his "Difference Engine," in 1882 after ten years of work. His new machine received a great deal of attention and the Royal Society and the British Government agreed to subsidize the building of the machine. The machine was never finished because of Babbage's interest in building a general purpose machine. Because of Babbage's shift of plans the government withdrew its support.

The new machine, which he had hopes of completing, was called the "Analytical Engine." Babbage's new machine was designed and partially built. The machine would have an arithmetic unit designed to perform calculations and a storage unit which would supply the data to be processed by the arithmetic unit. There would also be a control unit to coordinate the other two units. This machine was important because these same basic principles are still used in computers today. Babbage died in 1871 without completing his project, but his plan would have produced the first digital computer. Because of this, Charles Babbage is known as the "father of the computer."

g. Mark I Computer

The first successful general purpose digital computer, the Harvard Mark I, was built by Professor Howard Aiken of Harvard. The Harvard Mark I was completed in May of 1944 and was presented to Harvard. It is still in working condition.

h. ENIAC

In 1945 Mr. John W. Mauchly and J.

Presper Eckert designed and built the Electronic Numerical Integrator and Calculator (ENIAC). It was used at the Aberdeen Proving Grounds in Maryland, and it was completely electronic except for its input/output mechanism. The computer weighed almost 30 tons and contained more than 18,000 vacuum tubes. It was designed to solve ballistics problems. Previously, control functions were performed by the slow movement of switches but these were replaced by the vacuum tube. This development made computations a thousand times as fast as those performed previously.

i. Univac

The Univac (Universal Automatic Calculator) was manufactured by Sperry-Rand Corporation. It is considered to be the first completely automatic data processing system. It was first used by the Bureau of Census in 1951.

j. Computer of today

The computer of today has many advancements over those described previously. Magnetic core rings, thin-film memory and integrated circuits used now are results of today's advanced technology. Computer systems are smaller, faster, and have a greater capacity. Operating speeds are often measured today in billionths of seconds. In view of the past technological improvements, it is impossible to say what even the near future holds.

B. Review Questions

1. What are the types of data processing? How do they differ?
2. What is an abacus?
3. Briefly, tell why each of the following men were important.
   a. Blaise Pascal
   b. Joseph Marie Jacquard
   c. Herman Hollerith
   d. James Powers
4. For what two machines is Charles P. Babbage known? Describe the function of each? Why is he important?
5. What was the first successful general purpose digital computer? Who built it?
6. What is ENIAC? Univac?

C. Laboratory Problem

Assign students outside research.

DIVISION II: PUNCHED CARD

A. Units of Instruction

The method of recording one transaction on a punched card is called the unit record principle. Each transaction and the information that pertains to that transaction is punched into one card.

1. The Punched Card (Foil 1)

   a. Size

      The punched card is 7⅜ inches long, 3¼ inches wide and .007 of an inch thick. Since the card is fed through the machine at high speeds, it is important to keep the size of the card to a close tolerance. For this reason, a high quality pulp is used in the card stock which will minimize expansion and contraction because of changes in temperature and humidity.

   b. Corner Cuts

      A diagonal cut across one of the corners of the card is used to identify a certain type of card. An example would be one card to be used for cash receipts and another for cash disbursements. Corner cuts are also used to insure that all cards are facing the same direction and are not upside down. Corner cuts are used on the upper left, upper right, or lower right corner of the card. A corner cut on the lower left will cause feed problems when used with the card-punch machines.

   c. Punch Positions

      There are 960 possible punching positions on a card. The positions are marked off in both columns and rows. (It is important to understand the differences between columns and rows.)

      1. Columns

         The punching positions are marked in eighty vertical sections called columns. Each column has twelve punching positions which are designated as 12, 11, (often referred to as "X") 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9 from the top of the card to the bottom.

      2. Rows

         The horizontal division of the card is made up of twelve sections of the card called rows. Each row has eighty punching positions (one for each column). There is one row for each of the 12 punching positions in a column: 12, 11, 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9 from the top to bottom.

   d. Portions of the card

      On a standard card the columns are numbered from left to right (1-80) between the zero and one row. The columns are also numbered just below the nine row. The actual punching position for the 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9 rows are printed on the card with their respective number for easy reference. The punching positions, however, of the 12 and 11 rows are not numbered on the card. This section is left blank for use in interpreting (printing) the data punched in the card.

      1. Zone Portion

         The top three rows of the card (12, 11, and 0) are known as the zone portion of the card, and they are used in conjunction with numeric punches to designate alphabetic information. The 11- and 12-rows are used for zone punching and special coding only.

      2. Numeric Portion

         The numeric portion is composed of the 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9 rows. The zero can be used for either a zone punch or a numeric punch in one particular column. It cannot be used for both a numeric punch and a zone punch in the same column.

   e. Edges and "face"

      1. The 12-edge is the top of the card above the 12 row.
      2. The 9-edge is the bottom of the card below the 9 row.
      3. The printed side of the card is called the face.

4. All machines do not feed cards into the machine in the same manner. If the cards are fed in 12-edge face down, the 12-edge will enter the machine first and the printed side will be down. If they enter 9-edge face down, the 9-edge will enter first and the card will have the printed side down.

2. Hollerith Code (Foil 2)

Information is recorded in the card by means of the punched hole. These holes in the card are machine readable. The data can then be processed since the machine can interpret the coded pattern of punched holes. Each column on the card can represent one character only. Since there are eighty columns in a card, a maximum of eighty characters can be punched in a card. There are three types of characters; numeric (0-9), alphabetic (A-Z) and certain special characters.

a. Numeric Coding

A number is recorded in the card by punching one hole in each column for each digit. Ex. A three digit number (892) would require three columns. The "8" would be punched in a column (perhaps column 53) in the eight row. The "9" would be punched in the next column in the nine row (column 54) and the 2 would be punched in the two row in the following column (column 55).

b. Alphabetic Coding

An alphabetic character is represented by a combination of one zone punch and one numeric punch in each column. The first nine letters of the alphabet (A-I) are a combination of a 12-punch (zone) and a corresponding numeric-punch 1 to 9. The next nine letters (J-R) are a combination of an 11-punch (zone) and a numeric-punch 1 to 9. The last eight letters (S-Z) are the combination of a zero punch (zone) and a numeric-punch 2 through 9. Since only 26 combinations are needed for the complete alphabet, the 0 and 1 combination is used to represent the slash (/).

c. Special Characters

It is also possible to punch certain characters in addition to alphabetic and numeric data. These characters are made up of one, two and three punches in a column.

3. Field (Foil 3)

a. Purpose

A field is one column or a group of columns reserved for the recording of a single fact.

b. Length

The length of a field is determined by the type of information. The field must be as long as the maximum length of the information to be entered in the field.

c. Recording in the Field

The column to the extreme left of a field is known as the high-order position since it has the greatest value. The column to the extreme right is the low-order position since it has the least value in the field. It is important that each character is recorded in the proper position (column).

1. Alphabetic

When information is punched in an alphabetic field the first letter is punched in the high-order position (first column of the field). If the alphabetic information does not completely fill the field the remaining columns are left blank.

2. Numeric

Each column in a numeric field has a definite value in the same manner in which each digit in a number has a definite value. Great care must be taken when punching to make sure that the proper digit is punched in the proper column. Numeric data is justified on the right or low-order side. If there are not enough significant digits to fill up the field, zeros should be added in the proper columns. These may be preceding zeros or following zeros depending upon

the data. If a field has no significant digits it is left blank. There is no need to punch zeros in all of the columns of the field if the field is to contain no information. It can be skipped.

4. Card Handling

   a. Storage

   Since changes in temperature and humidity will cause changes in the size and weight of a card, it is necessary to store cards in an area where temperature and humidity can be controlled. The storage area should be kept at the same relative humidity as the working area to keep the cards from becoming warped when introduced to the working area. Cards should not be stored near heating pipes, radiators, or places that are hot and dry. The optimum relative humidity is between 30% and 65%. The maximum is 75% at 73 F°. The minimum allowable relative humidity is 10%. If the working area and storage area cannot be kept at the same levels, the cards should be allowed to achieve the moisture balance in the working area before they are to be used.

   It is important to keep the edges of a card in good condition. Cards with bent edges will cause card jams when they are fed through the machine. Avoid using paper clips on cards, and when rubber bands are used they should not be binding and should be placed off center.

   b. Housekeeping

   It is important that the working area be kept in a neat condition. Unuseable cards should be thrown away and not be kept on the equipment. This is important to avoid incorrect cards from being mixed with correct cards.

B. Review Questions

1. Define
   a. Unit Record Principle
   b. Column
   c. Row
   d. 9-edge
   e. 12-edge
   f. Face-up
   g. Field
2. What is the size of a standard 80-column punched card?
3. What are corner cuts and why are they used?
4. How many possible punching positions are there in a standard 80-column card?
5. What is the "X" row?
6. What rows make up the zone portion of the card? What rows make up the numeric portions of the card?
7. As represented in Hollerith Code what is the difference between a numeric character and an alphabetic character?
8. What determines the maximum length of a field?
9. a. How is alphabetic data recorded in a field?
   b. How is numeric data recorded in a field?
   c. What are the high-order and low-order positions of a field?
10. What should be taken into consideration in the storage of cards?
11. Should paper clips be used on cards? Why?

C. Laboratory Problem

Collect various samples of punched cards to be used as examples; types of cards, rows, columns, and corner cuts.

DIVISION III: ELEMENTS OF A DATA PROCESSING SYSTEM

A. Units of Instruction

1. Systems

   A data processing system is a logical method to carry out the overall program of the business. The business data processing system must be analyzed, and methods established to process the data.

2. Elements of a Data Processing System

   Any data processing system, (manual, mechanical, electromechanical, or electronic) must be composed of the following parts.

   a. Input

      Input is the entry of data into the system. There are different ways in which data can enter the system. The type of input which is used will depend upon the system being used. An adding machine uses a keyboard for input while a computer system might use punched cards or magnetic tape.

   b. Processing

      Once the data has been entered into the system it must be processed. The type of processing will again depend upon the system and the job that is being done. Data could be added, subtracted, or moved from one place to another.

   c. Output

      The output of the system is the result of the processing. The output from the adding machine is the total and the output from the computer could be a printed report.

   d. Storage

      Storage is the retaining of data in the system. Storage can be either internal or external. Internal storage is temporary retention of data within the system. External storage is data which is retained outside the system. The counters in an adding machine would be an example of internal storage and the adding machine tape would be external storage.

B. Review Questions

1. What is a system?
2. Describe the elements of any data processing system.

C. Laboratory Problem

Give examples of input, processing storage and output for different types of data processing systems.

PART II

UNIT RECORD EQUIPMENT

DIVISION IV: ELEMENTS OF A UNIT RECORD SYSTEM AND MACHINE CHARACTERISTICS

A. Units of Instruction

1. Systems

   A system is a logical method to carry out the over-all program of the business. The program of the business must be analyzed, and methods of processing data must be established to handle each part of the business system.

2. Elements of a Unit Record System

   a. Origination

      Origination is the first step in the data processing system. This step is the creation of the data which are recorded in a source document. With the purchase of merchandise in a store, data is created about that sale: the date of the sale, the amount paid or charged, etc.

   b. Input

      Input refers to the media of getting data into the system. The media in which data is entered into the unit record system is through the punched card.

   c. Processing

      Processing is the actual manipulation of the data from the cards. This includes the following operations:

      (1) Coding

      Before data can be processed it must be coded. Values are assigned to the data to represent it in a form which aids processing. Examples of coding are customer number, salesman number, and employee number. Coding is normally a manual operation.

      (2) Recording

      After the data have been coded it must be transferred from the source document into the punched card. This operation is known as recording and is performed in the unit record system by the keypunch. Once the data are recorded in the card it is sometimes necessary to punch this same data into other cards by means of the reproducer. It is also practical on occasions to have data which is punched into the card printed on the card. The interpreter is used for this operation.

      (3) File Maintenance

      Once data enters into the system, it is normally arranged into some meaningful order. It might be necessary, for example, to arrange the data into customer number order for one operation and to arrange the same data by salesman number for another operation. The sorter and the collator are used in the unit record system to perform the file maintenance operations.

      (4) Calculating

      The calculating function includes all of the arithmetic operations. The calculating punch (not included in this study) is one machine in the unit record system which performs this function. Calculations are made by the machine and the results are punched into the card. The accounting machine also performs the calculating function (addition and subtraction) during the summarizing function.

      (5) Summarizing

      The summarizing function reduces the data into a concise, meaningful form. The accounting machine is

used to perform this function in the unit record system.

d. Storage

Storage is the retaining of data within the system. If it is stored within the machine, it is known as internal storage. Counters within the accounting machine are an example of internal storage. External storage is data which are stored outside of the system. An example of external storage is the punched card.

e. Output

After the data have been processed it must be communicated among those who will use it. The data must be first taken out of the system and presented in some meaningful form which is normally a printed report. Output is the ultimate goal of the system. The accounting machine is used for the output function in the unit record system.

3. Reading a Card

(a) Metal Brushes

Most IBM machines discussed in this section use brushes and contact rollers to read the data punched in the cards. The number of brushes varies with each machine. The 82 sorter has only 1 brush. The 514 reproducer has 3 sets of 80 brushes plus 11 other brushes used for special purposes. The 402 accounting machine has two reading stations with 80 brushes in each.

(b) Completion of an Electrical Circuit

In all of the above examples, the method by which the machine reads the card is the same. When there is a punch that is being "read" there is a completion of an electrical circuit. When there is no punch being read there is no completion of the circuit.

(c) Operation

The card passes between the contact roller and the brushes. The contact roller is constantly being electrically charged. When the brush encounters a punch in a card, the brush falls through the hole and makes contact with the roller and thus completes the electrical circuit. The card acts somewhat like a switch in completing and disconnecting the electrical circuit.

4. Timing

Timing refers to the position of the card when it is being read. If the 5-row is being read the card is said to be at "5-time." An electrical impulse, when available at that time, will cause a 5 to be punched or printed depending upon the operation being performed.

5. Cycles

A cycle is the period (time interval) required to complete a series of events or operations that occur in an orderly manner. Each IBM machine performs its function within a given time called a machine cycle. Each machine operates at a certain number of machine cycles per minute.

A machine may be capable of performing several functions such as feeding cards, printing, or punching. If card feeding is occuring during the cycle, then it is called a card feed cycle. A machine cycle can be qualified by any function occurring during the cycle, such as a print cycle, a total cycle, or a punch cycle.

B. Review Questions

1. What is a system?
2. What are the elements that make up a system?
3. What is the function of the brush and the contact roller? Describe the operation.
4. Why is timing important? What are cycles?

C. Laboratory Problem

Give examples of how data would flow through a unit record system.

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DIVISION V: KEYPUNCH—RECORDING FUNCTION

A. Units of Instruction

1. Function of Keypunch

The function of the keypunch is to punch data into cards. Data must be transcribed from the original source document into a punched card by the operator. The source document may be a check, invoice, purchase order, sales ticket, time cards or any other document used in the organization. The data from the source document are punched into fields which have been predetermined before the operation.

There are three IBM alphanumerical keypunches that are available, the IBM 24, 26, and 29. The 26 will print across the top of the card above the 12 row and the 24 will not. Except for this feature the two keypunches look and operate in a similar manner.

The 29 is a newer model. It has several features which make it a more versatile machine; however, the 29 operates in the same basic manner as the 24 and 26. The material in this division can be used for any of the above models.

2. Features of the Keypunch

a. Card Hopper

The card hopper is located in the upper right-hand corner of the machine, and will hold approximately 500 cards. Blank cards are placed in the machine nine-edge first with the face toward the operator. A sliding pressure plate holds the cards to aid proper feeding.

b. Card Bed

The card bed is that area of the keypunch where the card passes from the card hopper to the card stacker. While the card is passing along the card bed, the card is punched at the punch station and then read at the read station.

c. Punch Station

The punch station is the first of two stations that the card passes in the card bed. Only one card passes through the punch station at a time. There are 12 punch dies in the punch station (one for each row of the card) which punch the holes in the card. One entire column is punched at a time starting with column number one, and working across the card to column eighty. If the keypunch is equipped with the print mechanism (26 and 29) the data being punched is also printed at the top of the card (above the 12-row). The data is printed directly above the column in which the data is punched.

d. Reading Station

The reading station is the second station in the card bed. The station is about one card length left of the punch station. This is where the cards are read for duplication function. After each card has passed through the punch station it moves to the read station. The card that has just been punched moves through the read station at the same time that the next card is being punched. The two stations are synchronized so that both are either reading (read station) or punching (punch station) column for column. As the read station is reading column one, the punch station is punching column one. When duplicating, the read station reads the card in the read station and the punch station punches what has just been read.

e. Card Stacker

The card stacker is on the upper left-hand side of the machine. After a card passes all the way through the read station, it is fed automatically into the stacker. The stacker will hold approximately 500 cards. The cards are stacked 12-edge down with the face away from the operator. The cards are held in position by a card weight. When the cards are removed from the stacker they are in the same sequence in which they were punched.

f. Main-line Switch

The main-line switch supplies electric power to the keypunch. It is located at the top of the stacker on the 24 and 26.

The machine takes about one-half minute to "warm-up." When the stacker fills, the switch automatically cuts the machine OFF. The main-line switch is under the reading board on the 29.

g. Keyboard (Foil 4)

(1) Types

(a) Numeric

The numeric keyboard consists of the numbers (0-9) and two special characters (— and S), plus machine functional keys.

(b) Combination Keyboard

The combination keyboard has keys for numbers (0-9), letters (A-Z) and 11 special characters. The combination keyboard uses the standard typewriter keyboard as well as the numeric keyboard. The numeric keys are on the same keys as some of the alphabetic keys. These dual purpose keys are located on the right side of the keyboard in a group that makes it possible to use a three-finger touch system. The touch system for these ten numerical keys is: index finger for digits 1, 4, 7; middle finger for 2, 5, and 8; and ring finger for digits 0, 3, 6, 9. The home keys are more concave than the other keys to aid the touch system. The keyboard is interlocked so that no two keys can be completely pressed at the same time, but it is not necessary to wait for one key to rise before pressing another key. This design permits a "rolling" of the keys.

(2) Functional Keys

(a) NUM (Numeric Shift)

The numeric shift is used to shift the keyboard into numeric mode as long as the key is depressed. This key can be used to override the program control unit.

(b) ALPH (Alphabetic Shift)

The alphabetic shift is used to shift the keyboard into alphabetic mode as long as the key is depressed. This key can be used to override the program control unit.

(c) DUP (Duplicate)

When the duplicate key is depressed the card in the read station is "read" and the data is punched into the following card in the punch station. Pressing this key once with the program control unit ON causes duplication of the entire field. Pressing the duplicate key with the program control OFF causes duplication as long as the key is depressed.

(d) REL (Release)

The release key causes the cards at both punch and read stations to be advanced past these stations.

(e) FEED (Card Feed)

The feed key causes a card to feed into the card bed from the hopper. When the key is depressed a second time, the first card will automatically register at the punch station and a second card will feed into the card bed.

(f) SKIP

The skip key causes the machine to skip over the field for which it is depressed. This key is used when under program control.

(g) REG (Card Register)

The register key is used to manually register cards at the punch and read stations.

(h) ALT PROG (Alternate Program)

The alternate program key causes the machine to shift to an alternate program instead of the normal program. This feature is optional.

(i) MULT PCH (Multiple Punch)

The multiple-punch key allows more than one punch to be punched in a single column. The keyboard is in numeric mode when this key is used.

(j) CORR (Card Correction)

The card correction key is used upon detection of an error before the next column is punched. The depressing of the key moves the card in error to the read station and duplicates a new card up to the error column. This feature is optional also.

h. Program Control Unit

(1) Purpose

The program control unit is located between the stacker and the hopper. The purpose of the program unit is to reduce punching time. It does this by automatic control of (1) duplication of common fields of data, (2) skipping over unused columns, (3) shifting from numeric mode to alphabetic mode, (4) suppressing print where desired (026) and (5) by printing left (preceding) zeros (026).

(2) Program Card (Foil 5)

A program card, which is a basic part of the program unit, is prepared for each different punching application. Each of several rows in the program card serves a specific purpose and is used to give instructions to the machine.

(3) Codes and Functions

(a) Field definition (12 punch)

A 12-punch is punched in every column except the first (left-hand or high-order position) of every field that is to skipped, duplicated or manually punched. These 12-punches serve to continue to the end of the field any skip or duplication started within that field. Several consecutive fields to be automatically skipped or several consecutive fields that are to be automatically duplicated are programmed as a single field. *Do not* program a single-column field with a 12-punch.

The 12-punches in the program card for manually punched fields permit occasional skipping or duplication. Skipping or duplication is started by the skip or duplicate key. The operation is continued through the field until a column is reached that does not have a 12-punch or an 11-punch.

(b) Automatic Skip (11)

An 11-punch starts automatic skipping, and the operation is continued through the field by the 12-punches in the remaining columns of the field. A single column to be automatically skipped, should be punched with an 11-punch. The automatic-skip-and-duplicate switch must be ON to start the skipping automatically with the 11-punch. The machine will stop skipping when it does *not* read a 12-or an 11-punch in the program card.

(c) Automatic Duplication (0)

A 0-punch in the first column of any field starts automatic duplication, and the operation is continued through that field

by the 12-punches in the remaining columns of the field. A single column to be automatically duplicated should be punched with a 0-punch. The automatic-skip-and-duplicate switch must be ON to start duplicating automatically with the 0-punch. The machine will continue to duplicate until it does not read a 12-or and 11-punch in the program card.

(d) Alphabetic Shift (1)

When the program control unit is turned ON by the program control lever the keyboard is *normally* in numeric shift. When any one of the combination keys (a key which is used to punch both letters and numbers) is pressed a number would be punched in the card. To punch a letter, the combination keyboard must be shifted from the numeric mode to the alphabetic mode. This shifting is performed automatically by a 1-punch in the program card in *each* column of the alphabetic field. During duplication of alphabetic information the 1-punches permit automatic spacing over blank columns and prevent X-skipping caused by letters containing X-punches (J through R).

The four basic program codes are described above. There are two additional codes that may be used on the 26 printing card punch.

(e) Left-zero print (2)

When the program control unit is ON, zeroes which are punched to the left of the first significant digit in a numeric field are automatically suppressed for each field that has been defined by 12-punches. (ex: 000072 is printed at the top of the card as 72). To force left zeros to print, it is necessary to punch a 2 in every column of the field in the program card. A zero in the low-order position of a field always prints unless printing is suppressed.

(f) Print suppression (3)

Even though the print switch is ON, printing can be prevented for one, or more columns of the card. To suppress printing a 3 should be punched in every column in a field of the program card that printing is to be suppressed.

(4) Program drum

The program card is mounted on the program drum for insertion into the machine. The program drum has a clamping strip to hold the card in place, and a handle on the top of the program drum to tighten or release the strip.

(5) Star-wheels

The sensing mechanisms which "read" the holes in the program card are called star-wheels. In order to read the program card they must be lowered so that they rest on the program card.

(6) Program Control Lever

The program control lever is located below the program control unit and just above the card bed. This lever raises and lowers the star-wheels. When the star-wheels are raised the program control unit is OFF and when the star-wheels are lowered the program unit is ON.

In addition to turning the program unit OFF and ON, the program control lever also controls the mode of the keypunch. When the control unit is OFF the keyboard is *normally* in alphabetic mode. If

a combination key is pushed it will punch a letter. In order to punch numeric characters, it is necessary to depress the numeric shift key at the same time each number is punched.

When the program unit is ON the keyboard is *normally* in numeric mode. The keypunch will shift to alphabetic mode automatically when a 1-punch is punched in the program card. If a numeric character is needed in a field programmed for the alphabetic mode, it is possible to override the program unit by holding down the numeric shift key. When punching a numeric field the program unit can be overridden by holding down the alphabetic shift key while the letter is punched.

(7) Column Indicator

The column indicator is located at the base of the program drum holder and indicates the next column to be punched. Refer to the column indicator for a guide for spacing or backspacing to a particular column.

i. Backspace Key

This key is located below the card bed between the reading and punch stations. As long as it is held down, the cards at the punch and reading stations will backspace (until column 1 is reached). At the same time, the program drum will also backspace for each column the cards backspace.

The keyboard will "lock" when there is no character to be punched by the key in that mode of shift (a key with no combination for that mode). The backspace key can be depressed to "unlock" the keyboard.

j. Functional Control Switches

These switches are located at the top of the keyboard.

(1) Print

The print switch is used on the 26 and 29. The machine will print across the top of the card when the print switch is ON (except in the case of print suppression which is controlled by the program control unit). When the switch is in an OFF position, it will not print at the top of the card regardless of the program control unit.

(2) Automatic duplication and automatic skipping. The automatic duplication and automatic skipping switch controls the automatic skipping and duplication of columns when the program control unit is ON. The switch has no effect when the program control unit is OFF. Since there is no card in the read station, when the *first* card is being punched, the switch should be OFF to keep the keyboard from locking when it reaches the duplicated field. After the *first* card has been punched the switch should be turned ON.

(3) Automatic feed

With the automatic feed switch ON the machine will automatically feed cards into the card bed when necessary. Card column 80 passes the punch station (1) the card at the left of the read station is stacked, (2) the card entering the read station is registered, (3) the card at the right of the punch station is registered and (4) another card is fed into the card bed. To start the operation two cards should be fed into the card bed.

k. Pressure-roll release lever

The pressure-roll release is located next to the column indicator. Pressing this lever will allow the manual removal of jammed cards from the punching or reading stations. Care should be taken when removing the card to be sure that it does not tear. If torn, pieces of the card caught in either station can be pushed out with another card or a smooth-edged

metal blade while holding down the pressure roll release lever. Do *not* use *saw-edged blades*.

l. Reading board

The reading board is the area on which the keyboard rests. It provides space for source documents when the cards are to be punched.

m. Chip box and fuses

The chip box is under the reading board. It catches the paper chips which are punched out by the punch dies. Fuses for the machine are also located in this area.

B. Review Questions

1. What is the function of the keypunch?
2. Explain the purpose of the following features on the keypunch:
   a. Card Bed
   b. Hopper
   c. Stacker
   d. Punch Station
   e. Reading Station
   f. Program Control Unit
   g. Backspace Key
3. What is the purpose of the following punches used on the program card: 12, 11, 0, 1, 2, and 3?
4. What is the sensing mechanism which reads the program drum?
5. What is the normal mode (shift) for the keyboard when the program control lever is OFF? When it is ON?
6. What is the purpose of each of the functional control switches on the keypunch?

C. Laboratory Problems

1. Keypunch, problem V-1
2. Program card, problem V-2
3. Keypunch and program card, problem V-3

DIVISION VI: SORTER—FILE MAINTENANCE

A. Units of Instruction

1. Purpose

Usually before data can be processed it has to be put into some type of orderly arrangement. Manual sorting of documents is both a tedious and time consuming operation.

The IBM sorter performs the file maintenance function, and can be used to sequence, select, or group cards at high speeds. The most common operation performed is sequencing. This operation includes either alphabetic or numeric data which can be arranged in either ascending or descending order.

The second operation performed is selecting. This operation allows certain cards to be removed from a file without disturbing the order of the remainder of the file. The third operation is grouping, which is the classifying of data by some common characteristic.

2. Features

The major differences in the models of sorters are the various speeds at which the models operate. Each machine has additional individual characteristics which add or detract from its flexibility. References in this section will be made to the IBM 82; however, the 83 and 84 are very similar. The IBM 82 will sort 650 cards per minute (the 82 Series 50 will sort 450 cards per minute), the 83 will sort 1,000 cards per minute, and the 84 will sort 2,000 cards per minute.

a. Main-Line Switch

The main-line switch supplies power to the machine. On the 82 this switch is located below the selection wheel. The warm-up period on this machine is approximately 60 seconds. On some machines when the machine is ready, a ready light is turned on.

b. Hopper

The hopper is located in the upper right-hand corner of the machine, and holds approximately 1200 cards. The cards which are to be sorted are placed in the hopper with the 9-edge first face down.

c. Pockets

The sorter has 13 pockets, since there is one pocket for each row on the card plus the reject pocket. A card with a 2 punched in the column will fall in the 2 pocket, and a card with no punches in the column will fall in the reject pocket. Each pocket will hold approximately 550 cards.

d. Start Key

The start key will cause the machine to begin feeding cards into the machine. The sorter will continue to run automatically until (1) the last card is fed through the machine; (2) any one of the pockets fills; (3) the stop key is pushed; or (4) when the cover over the brush assembly is lifted.

e. Stop Key

The stop key will cause the machine to stop feeding cards through the machine. When this key is pushed, the cards will not continue to their respective pockets.

f. Sort Brush and Contact Roller (Foil 6)

The IBM 82, and the 82 Series 50, and the 83 all use a sort brush and a contact roller. The sorter will sort *only* one column at a time. The IBM 84 does not use a sort brush and a contact roller; instead it uses a light (taking the place of the contact roller) and a photoelectric cell (which takes the place of the brush.) The 84 also sorts *only* one column at a time.

g. Chute Blades (Foil 6)

The chute blades are bands of metal of varying length, that guide the cards on their way from the sort brush to the proper pocket. There are 12 chute blades. There is no chute blade for the reject pocket.

h. Column Indicator (Foil 7)

The column indicator is located to the left of the hopper. It is marked off in positions from 1 to 80 corresponding to

the 80 columns on the cards. The column indicator is attached to the sort brush mechanism to indicate which column the sort brush is set to "read."

i. Column-Selector Handle (Foil 7)

The column-selector handle is used to move the sort brush to the desired column that is to be sorted. One full turn moves the sort brush one column.

j. Finger Lever (Foil 7)

The finger lever allows the sort brush to be moved over a number of columns without making one full turn of the column selector handle for each column. To move the brush across several columns, turn the column selector to the upper position (so the indicator is between columns) push down the finger lever and move it to the desired column. Then turn the column selector handle to the down position. Be sure to check the indicator after it is moved to be sure the indicator is on the proper column.

k. Selection Switches (Foil 7)

The selection switches allow the operator to determine which rows will be sorted. There are 13 selection switches, 12 black switches that correspond to the 12 rows on the card and a longer red switch known as the alphabetic sort switch (or alpha switch). The 13 selection switches are located on the outer edge of the selection wheel. These switches can be pushed either toward the center or the outer edge of the circle. When pushed toward the center, the selection switch suppresses sorting of the corresponding row and the machine rejects all cards punched in that row, unless another punch is in the column which is not suppressed. The alphabetic sort switch is used to sort only the 0, 11 and 12 rows. It has the same effect as setting toward the center all the switches from 1-9. The alpha switch is used in alphabetic sorting to sort the zone portion of the card.

l. Hand Feed Wheel

The hand feed wheel is located on the right side of the machine. It is used to test the machine and remove jammed cards. To use the wheel it is pushed in and turned manually.

3. Machine Operation (Foil 6)

As the card enters the machine (9-edge face down), the card passes between the sort brush and the contact roller. The edge of the card passes under the tip of the 9-chute-blade then the 8-blade, etc. A card with a 7-punch in the column being sorted would pass under the 9- and 8-blade. The tips of the blades are spaced in such a manner that when the sort brush drops through the 7-punch in the card, the leading edge has passed under the 8-blade. The 9-edge of the card is between the 7- and 8-blade. The electric circuit is closed by the sort brush making contact with the contact roller. When this condition exists, the electro-magnets are magnetized which pull down on the chute blades and force the card into the passage between the 7- and 8-blades. Carrier rollers are used to convey the card into the 7-pocket. Cards which have a double punch (two punches in the same column) will fall in the pocket of the punch that is read first. Since cards enter 9-edge first, it will "read" the punch that is nearest the 9-edge of the card. The selection switches can be used to control the rows which are read.

4. Sequencing (Sorting)

a. Purpose

Sequencing is the arrangement of data in either ascending or descending order, although most data is arranged in ascending sequence. Sequencing can be done for either alphabetic or numeric data.

b. Operation

(1) Numerical Sequencing

To arrange data in numerical sequence all selection switches should be in the outer position. A numeric field requires one pass through the

machine for each column in the field. The first column to be sorted is the low-order position (right-hand column). To remove the cards from the machine the operator starts at the right-hand side and works toward the left placing each group of cards on top of the cards which have previously been removed. The cards are placed back in the hopper and the next column to the left is sorted. This process is continued until the last column in the field (high order) is sorted.

(2) Alphabetic Sequencing

Since alphabetic characters are represented by two punches in a column (a numeric and a zone punch), each column requires two sorts. In alphabetic sequencing, as in numeric sequencing, the low-order position is sorted first. First, each column must be sorted by the numeric punches, and then the same column is sorted by the zone punches. On the first sort of the column, all selection switches should be in the outer position. On the second sort the red alpha-switch should be set toward the center to enable the operator to sort only the zone punches. *Always reset the red alpha-switch before sorting the next column.* Since alphabetic material is not always the same length, it is possible for some cards to fall in the reject pocket on the first sort. On the second sort, it is not essential for the operator to resort the rejected cards for that column since they will automatically fall in the same order, in the reject pocket. After the second sort, they are placed in the hopper with the other cards to sort the next column.

(3) Sorting More Than One Field

There will be occasions when the operator will find it necessary to sort by more than one field. For instance, it may be necessary to arrange cards by three fields: a state code, a city code, and a store number. The largest or most important group (state) is called the major field. The middle group (city) is called the intermediate field, and the least important group (store) is called the minor field. It is possible to think of all three fields as one large field. The major field would be the high-order positions, the intermediate fields would be the intermediate-order positions, and the minor field would be the low-order positions. The cards would be sorted beginning with the minor field, followed by the intermediate field and then by the major field.

(4) Block Sorting

Cards are usually sorted beginning with the low-order position and working toward the high-order position. It may aid the operation being performed to separate the cards into smaller groups by sorting the high-order position first when a large number of cards are being sorted. For example, cards with fields beginning with any digit are separated into digit groups. After the cards have been broken down into groups, each block is sorted in the usual manner beginning with the low-order position. It should be noted that it will not be necessary to sort the high-order position of each group again since each group will have the same punch in the high-order position. After the first block has been completely sorted it is possible to process this group in another machine while the next group is being sorted. Block sorting thus reduces the overall time of processing a report since it is possible to use two machines at the same time. Another advantage is that an error is localized to one particular block. Block sorting also

makes it easier to handle large numbers of cards, and allows two sorters to be used in the sorting operation.

5. Selecting

   a. Purpose

      Selection is the removal of cards from a deck without disturbing the original order of the deck. An example would be a deck of cards that have previously been sequenced in a customer number order. It is possible to remove all the cards which are for store number 4 and retain the rest of the deck in the original customer number order.

   b. Operation (Foil 7)

      The selection switches play a major role in the selection of cards from a deck. In the above example the store number could be in column 40, and the column indicator would be set above column 40. All cards which are for store number 4 should have a 4 punched in column 40. The object of the operation is to get all cards for store 4 to fall in the 4 pocket and the remainder of the cards to fall in the reject pocket. This is done by setting the black selection switches for any possible punch that the operator does not wish to sort (in this case, 12, 11, 0, 1, 2, 3, 5, 6, 7, 8, and 9) toward the center of the circle. Do not set the alpha-switch toward the center.

      It is possible to select out more than one group. In each case, selection switches which are set toward the center of the circle will be ones to cause cards to fall into the reject pocket and not those that are to be selected out of the deck. Those left in the "out" position will cause those particular rows to sort or select.

6. Grouping

   a. Purpose

      Grouping is the classifying of a deck of cards by some common characteristic. An example of this would be a deck of cards with one card for each student at a school; each card could identify the student by a code as to class rank: freshman (1), sophomore (2), junior (3), and senior (4). By sorting the column containing this code the cards would be grouped by their common characteristic, the class rank.

   b. Operation

      Grouping is done by sorting the column which contains the common characteristic. In the example given above, the column indicator is set to sort the column containing the class rank code. All cards should fall in either the 1, 2, 3, or 4 pocket.

B. Review Questions

1. What is the purpose of the sorter? What operations is the sorter used to perform? What are they?
2. What are the various speeds of IBM sorters?
3. Why are there 13 pockets on the sorter?
4. What conditions will cause the sorter to stop feeding cards?
5. What is the purpose of the following?
   a. Sort brush
   b. Chute blades
   c. Column indicator
   d. Selection switches
6. Compare and contrast the operations necessary to sequence alphabetic and numeric data.
7. How are cards sorted on more than one field?
8. What is block sorting and why is it used?
9. What is the importance of selection switches in selecting?

C. Laboratory Problems

1. Sequencing, problem VI-1
2. Selection, problem VI-2
3. Grouping, problem VI-3
4. Sequence by more than one field, problem VI-4
5. Sequence by more than one field, problem VI-5

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DIVISION VII: WIRING FUNDAMENTALS

A. Units of Instruction

1. Purpose of the Control Panel

The machines which have been described previously did not use a control panel. Most IBM unit record machines do use some type of control panel to give instructions to the machine. The control panel gives the equipment flexibility and allows the same machine to perform many different operations.

The control panel has many small holes called hubs through which specially made wires can be inserted. Various instructions are given to the machine according to how the wires are inserted in the control panel. These wires complete an electrical circuit.

2. Internal and External Wiring

Wiring in IBM machines using control panels is of two types (1) internal wiring and (2) external wiring. Internal wiring is the wiring which is built into the machine by the manufacturer. External wiring (control panel) is used to complete the internal electrical circuits and is wired by the operator. The completed electrical circuits are used to give instructions to the machine about a particular operation. The internal circuits are connected to rows of metal prongs that are the ends of the internal circuits. When the control panel is fitted into place, the wires in the control panel (external wiring) complete the electrical circuit with the internal wiring and therefore, give instructions to the machine.

3. Physical Characteristics

a. Control Panel

There are two basic types of control panels. Each control panel uses a wire which fits that type of panel.

(1) Jack Panels

A jack panel has metal prongs or contacts, that press against the stationary internal contacts when the panel is inserted into the machine. The external wires plug into these metal prongs to complete the electrical circuit.

(2) Self-contacting (direct contacting)

The self-contacting panel does not have metal prongs connected to the panel. The wires used for this panel have longer and larger tips that pass through the control panel and press directly against the stationary prongs. These panels are considerably lighter than the older jack panels.

b. Size of Panel

The size of the panel depends upon the machine and how many operations it can perform. The more functions it can perform the more hubs that are necessary and the larger the panel that is used.

c. Hubs

(1) Exits and Entries

The hubs which accept electric impulses are called entries; those which emit impulses are called exits. An exit must always be wired to an entry.

(2) Single and Common Hubs

Hubs may be single, or there may be two or more hubs internally connected to each other. These internally connected hubs are known as common hubs, and are identified on the control panel by lines connecting them. If the common hubs are exits, the exit impulse is available out of all the hubs connected together. If the common hubs are entries, an impulse wired externally into any one of the connected hubs is directed into the machine and is also available out (exit) of the other common hubs.

(3) Bus Hubs

Bus hubs are several hubs internally connected to each other, but not connected to any internal machine circuit. They are neither exit nor entries until they have been con-

nected to another exit or entry hub. Once an impulse from an exit hub is wired to a bus hub all the connected bus hubs become exits for that same impulse. These hubs are used to avoid split wires.

(4) Switch

Two externally adjacent hubs which are connected on the control panel by an arrow indicate a switch. When these two hubs are wired together they turn ON some mechanism within the machine.

4. Wires

a. Purpose

Wires are used to complete the electrical circuitry of the machine and give instructions to the machine.

b. Color

The color of the wire indicates only the length of the wire. The different colors allow the wires to be sorted according to their length. Control panels should be wired with the shortest wires possible (without stretching) to avoid excess bulk.

c. Types

(1) Fixed

Fixed wires are used on control panels wired for an operation which will be used many times without change. These wires once inserted can not be pulled out without the use of a special wiring tool.

(2) Temporary

Control panels which are used only once or are subject to change are usually wired with temporary wires. These wires can be removed without the use of the wiring tool.

d. Jack plugs

Jack plugs are wires designed to externally connect two adjacent hubs. A regular wire could be used; but a jack plug is more convenient and less bulky.

e. Split wires

Split wires are wires which have more than two ends, and can be used when there are no bus hubs available.

f. Common connectors

Split wires are not made with temporary plugs. If bus hubs are not available and temporary wires are being used, it is possible to use a common connector instead of a split wire. An impulse brought into the common connector is available at the other terminals of the connector.

5. Control Panel Diagrams

Paper diagrams (drawings) of the hub layout on each type of control panel are available, to keep a permanent record of a control panel setup. To make diagrams as legible as possible follow these rules.

a. Use different colored pencils to represent wiring that makes the machine perform different functions. For instance, wiring for printing might be a different color than wiring for addition.

b. Pencil in the hubs at either end of the field and connect these hubs with a horizontal line.

c. Connect the exit and entry fields by *one* line. The use of one line for each field makes the diagram easier to read. Although only one line is shown on the diagram, a four position field requires four wires and a six position field requires six wires, etc., in the control panel.

d. Indicate exit and entry hubs by drawing an arrow pointing to the entry hubs.

e. When it is necessary to cross lines on a diagram break one line or "hump" it over the other. This prevents the possibility of following the wrong line to the entry hub.

B. Review Questions

1. What is the purpose of a control panel.
2. Explain the difference between external and internal wiring.
3. What is the difference between a jack panel and a self-contacting panel?

4. What determines the size of a control panel?

5. Define
   a. Exit hubs
   b. Entry hubs
   c. Common hubs
   d. Bus hubs
   e. Fixed wires
   f. Temporary wires
   g. Jack plugs
   h. Split wires
   i. Common connectors

6. What are control panel diagrams? How are they used?

7. What are the 5 rules to follow to make diagrams legible?

C. Laboratory Problems

Demonstrate control panels for various machines, wires and control panel diagrams.

DIVISION VIII: INTERPRETER—RECORDING FUNCTION

A. Units of Instruction

1. General Information

a. Function

The function of the interpreter is to print on the card the data which is punched into the card. It is easy for machines to read the punched holes, and to process the data. Such processing of the punched card by humans is not as easy since they find this means of recording data cumbersome. The interpreter reads the card and prints the data on the card. This makes human processing of the cards faster and more efficient.

b. IBM 548, and 552 and 557

The 548 and 552 interpreters are similar machines, but the 552 is no longer in production. The 557 is a more versatile machine than either the 548 or 552. Reference will be made to some of the differences in these models.

c. Printing Lines (Foil 8)

The 548 and 552 will print on two lines of 60 characers each. This makes it possible to have a maximum of 120 characters on one card. One line of print is just above the 12 row and the other line is between the 11- and 12-rows. The 557 also uses a 60 space line, but there are 25 possible lines of print instead of only two. Twelve of these lines are located between the twelve rows of the card, and one line is above the 12-row, and another line is below the 9-row. Since there are only 60 spaces to a line and there are 80 card columns, if the entire card is to be interpreted it is necessary to use two lines and pass the cards through the machine twice using two different control panels. It is impossible to interpret directly above the column containing the data.

It may aid certain operations to have data interpreted twice on the same card. Such an example would be, a code that is used in the manual handling of cards. This code could be printed at each end of the card and thus make it possible to locate the card by using either end of the card.

d. Feeding the Cards

Cards are placed into the 548 and 552 hopper with the 12-edge first face-*up*. This unusual manner of feeding the cards causes the normal method of handling cards to be reversed. The operator should start at the back of the tray and work toward the front.

The 557 feeds the cards with the 12-edge face-*down*. This allows the cards to be handled by the operator in a normal manner.

e. Speed of the Machine

The 548 and 552 operate at a rate of 60 cards per minute, but the 557 will operate at 100 cards per minute.

f. Setting the Line of Print

It is necessary to pass the cards through the machine once for each line of print. The 548 and 552 have a line-selection knob that is located at the rear of the machine to change the line of print. The 557 uses a line-selection dial to set any one of the 25 lines of print.

g. Control Panel (Foils 8 and 9)

A single control panel is a characteristic of both the 548 and the 552. The 548 uses a self-contacting (direct-contact) control panel and the 552 uses a jack-type control panel. The 557 uses a self-contacting control panel with two sections.

h. 80 Reading Brushes (Foil 8 A-D, 1-20)

The interpreter has 80 reading brushes (one for each column). These brushes determine what will be printed according to the manner in which the brushes are wired to the typebars. There is a set of 80 exit hubs on the panel which correspond to each of the 80 reading brushes.

i. Print Entry (Foil 8 M-S, 1-20)

The hubs which are connected to the print mechanism are called print entries. The 548 and the 552 use typebars and the 557 uses print wheels. These mechanisms are internally connected to the print entries. The 548 and the 552 contain 60 typebars with each bar containing 39 possible positions: 10 numerical (0-9), 26 alphabetic (A-Z), and 3 special characters. There is one typebar to correspond to each print entry on the control panel. The typebar moves down until it is in the proper position to print the character which was "read" by the reading brushes. The 557 uses typewheels instead of typebars. The wheel turns to the proper position to enable the desired character to be printed.

2. Operating Features of 548

a. Hopper

The hopper is located in the upper right-hand corner of the machine. When the supply of cards is exhausted, all the cards that are within the machine will first be interpreted and then run out into the stacker and the machine will stop. The hopper will hold approximately 700 cards. The cards are fed into the machine with the 12-edge first face up.

b. Card Stacker

The stacker is located directly below the hopper. The stacker will hold approximately 900 cards. When the stacker fills the machine will stop.

c. Main Line Switch

The main line switch supplies the machine with electric power. When the switch is ON a green "Ready" light next to it will come on.

d. Start and Stop Keys

The start and stop keys are next to the green ready light. The start key, which is blue, must be pressed for three feed cycles to start feeding cards into the machine. The machine will continue to operate until (1) the stacker becomes full or (2) the last card is fed through the machine. The stop key will stop the operation of the machine at any time while cards are feeding.

e. Printing Position Knob

The printing position knob selects the line of print. The knob is located at the rear of the machine. To change the line of print, the knob is pulled out and turned clockwise for the upper line or counter-clockwise for the lower line. The knob rotates while the machine is running.

f. X-Brushes (Foil 8 N-S, 21 and 22)

The 548 has a set of five X-brushes located in such a manner that they "read" a card just before it passes under the reading brushes. These brushes are timed to "read" only the X-punch (11-row). The brushes can be positioned manually over any of the 80 columns, but two columns *must* separate adjacent brushes. If there is an X-punch in the card that is "read," an impulse will be available at the two common X-brush hubs on the panel.

3. Control Panel Wiring (Foil 8)

The basic control panel wiring for the 548 is from reading brushes to print entries. One end of the wire connects the reading brush of the column, which is to be read, to the typebar which is to print. For example, if card columns 5-10 were to be printed in typebars 22-27, one wire would connect the reading brush hub 5 to the print entry 22. Another would connect reading brush 6 with typebar 23. The same pattern would be followed through the field with one wire for each column to be "read."

It is possible to print the same field in two places on the same line. This can be done without split-wiring since each print entry has two common hubs. It is possible to wire out of the common hubs into another print entry, and thus, print the same data twice on the card.

4. X-Elimination (Column splits)

a. Function (Foils 10 and 11)

Some numerical fields may contain an X-punch in one of the columns in the

field to indicate a negative number, or to be used as a control punch. If the column that contains the X-punch is wired directly to the print entry, the interpreter will print an alphabetic character. The X-eliminator is used to prevent the X-punch from reaching the print entry.

b. Wiring and Operation (Foil 8 E-H, 1-22)

The X-eliminator has four rows of hubs; two rows are the common hubs, one row is the 0-9 hubs, and the other row is the 11-12 hubs. These hubs can be used as either an entry or an exit depending upon their application. There is a connection between either the common hubs and the 0-9 hubs, or the common hubs and the 11-12 hubs. At 11- and 12-time there is a connection between the common hubs and the 11-12 hubs. From 0-time to 9-time, there is a connection between the common and 0-9 hubs. By wiring from the reading brush to the common hub and the 0-9 hubs to the print entry, the X-punch in a numerical field will not print an alphabetical character. This device is called a column-split on other IBM machines.

One group of ten eliminators is standard on the 548, while another group of ten positions is optional. Each group on the control panel has a switch that must be wired "ON" for the X-eliminator to be functional.

5. Zero-Elimination

a. Function

Printing of insignificant hign order zeros can be prevented by the use of the zero-elimination hubs. Zero-elimination is an optional feature on the machine.

b. Wiring (Foil 8 T-W, 1-20)

The reading brushes are wired to the print entry. The common hubs of the print entry are wired to the top row of the zero-elimination hubs. Any group of the zero-elimination hubs may be used provided all the hubs for the same field are adjacent. The other three rows are jack-plugged as follows: below the hub wired to the high-order position, jack-plug the two upper hubs; below the hubs wired to all other positions of the field, jack-plug the two lower hubs.

6. Selectors

a. Function (Foils 12 and 13)

The selectors allow a choice between two conditions. Each selector has three sets of hubs: a set of five common hubs, a set of five normal hubs, and a set of five transferred hubs. There are also two common pickup hubs for each selector. Normally, there is a connection between each common hub and the normal hub directly above it. If the selector is transferred, however, there is a connection between the common hub and the transfer hub directly above the "normal" row. Pickup hubs are usually wired from the X-brushes. If the X-brush reads an X-punch in the card, the selector will transfer and stay transferred until the end of that card cycle.

b. Class Selection (Foil 8 J-L, 1-22)

Class selection means that a field in the card may be printed in one of two possible places or whether the field will print under certain conditions. Whether there is an X-punch in the card determines in which position the field is printed.

The basic wiring is from the reading brushes into the common hubs of the selector. The normal hubs are wired to one group of print entries and the transfer hubs are wired to the other group of entries. The print entries which will print when there is no X-punch present should be wired to the normal hubs, and those which are to print when an X-punch is present should be wired to the transfer hubs. It is also necessary to wire the X-brush, which must be set over the column to be read, to the selector pick-up hub.

c. Field Selection (Foil 8 J-L, 1-22)

Field selection means that one of the two fields in a card will be printed in one

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set of typebars. Whether there is an X-punch in the card determines which field will be printed. The basic wiring pattern is from the reading brushes which contain the field that will be printed, with no X-punch, into the normal hubs of the selector. The field which will be printed, when there is an X-punch, is wired into the transfer hubs of the selector. The common hubs of the selector are wired to the print entries.

B. Review Questions

1. What is the function of the interpreter? Why is it necessary?
2. How many print lines are possible on a card for a 548, 552, and 557? How many characters can be printed on a single line?
3. What is the importance of the entry of the cards into the different machines?
4. What conditions will cause the machine to stop feeding cards through the machine?
5. How is a control panel wired to read the cards and print the data on the card?
6. What are X-eliminators? How do they operate? How are they wired?
7. What is zero-elimination? How does it operate? How is it wired?
8. Why are selectors used? Explain how they operate.
9. Compare and contrast class selection and field selection.

C. Laboratory Problems

1. Read to print, VIII-1
2. X-elimination, VIII-2
3. Class selection, VIII-3
4. Field selection, VIII-4

DIVISION IX: REPRODUCER—RECORDING FUNCTION

A. Units of Instruction

1. Function of the Reproducer

The reproducer is used to duplicate data which has already been captured in punch card form.

The reproducer performs 4 basic operations; (1) straight reproducing, (2) gang punching, (3) mark sensing and (4) summary punching.

a. Straight Reproducing

The duplication of the data captured in one deck of cards is known as straight reproducing. The reproducer "reads" the data punched in one deck of cards and punches the same data into another deck. There is one duplicate for each original in which the whole card or part of the card may be reproduced. Data can also be transferred from one group of columns in one deck of cards to another group of columns in the duplicate deck.

b. Gang punching

Gang punching is the same basic operation as duplication on the keypunch. The data from one card is punched into the following card, and then the data in that card is punched into the next card, etc.

c. Mark Sensing

Mark sensing is the automatic conversion of a manually marked card into punched holes in the same card. These marks must be able to conduct electricity. This is not a standard feature on the machine.

d. Summary Punching

The accounting machine and the reproducer can be used together to summarize information and then punch that information into a card. This method is often used to update accounts. A new balance is computed for each account by use of the counters in the accounting machine. The new balance is then relayed through the summary punch cable where it is punched into a new card. This function will be explained more fully in the section concerning the accounting machine.

2. Features

This division will be concerned with the IBM 514 Reproducer. The 513 is similar to the 514. Other models of reproducers are the 519 and the 528.

a. Hoppers

The 514 has two hoppers which hold approximately 800 cards apiece. There is a hopper for the read unit and one for the punch unit. The cards are fed into the machine with the 12-edge face-down. The machine will automatically stop when the last card from either hopper feeds into the machine.

b. Stackers

There are two stackers, and each will hold approximately 1,000 cards. There is one stacker for the read unit and one stacker for the punch unit. When either stacker fills, the machine will automatically stop.

c. Main Line Switch

The main line switch controls the power supply. There is a red light which comes ON when the switch is turned ON.

d. Start and Stop Keys

These keys start and stop the cards from feeding through the machine. They control both the reading and the punch unit.

e. Read Unit

The read unit is located on the left side of the machine. It consists of a hopper, 5 read X-brushes (RX), 80 reproducing brushes, 80 comparing brushes, and a stacker. It takes 3 card cycles for the card to pass through the unit. On the first cycle, the card is "read" by RX and reproducing brushes. The RX brushes do not take a full card cycle but are set only slightly ahead of the reproducing brushes. The comparing brushes "read" the card on the second card cycle and on the third cycle, the cards are rejected into the stacker.

f. Punch Unit

The punch is composed of a hopper, six punch X-brushes (PX), 80 punch dies, 80 punch brushes and a stacker. On the first card cycle the card is "read" by the six PX brushes just before they enter the punch dies. It is while the card is under the punch dies that the card is punched, which is the only place on the machine that will punch the card. On the second card cycle, the punch brushes "read" the card and on the third cycle the card is ejected into the stacker. If the machine is equipped with mark-sensing, the mark-sensing brushes are between the PX brushes and the punch dies.

g. Comparing Unit (Foils 14 and 15)

(1) Function

The comparing unit is used to determine the accuracy of the cards which have been punched. The comparison may be between one card in the read unit and one in the punch unit or between two cards in read unit. When the comparing unit finds two cards which have not been punched correctly, the machine stops and indicates the error. The comparing indicator indicates the set of comparing magnets that have found an error. The restoring lever is used to reset the unit and turn off the compare light.

(2) Operation (Foil 16 Y-FF, 1-20)

The comparing unit has two sets of hubs on the panel. Each comparing unit consists of 80 pairs of electromagnets. (Some machines do not have a full complement of compare magnets.) A brush from one station is wired to one side of a compare unit, and a brush from another station is wired to the other side of the same compare unit. The reading brushes drop through holes in the cards and the wires carry the electrical impulses to the comparing electromagnets to which they are attached. Whenever one magnet energizes and the other does not at the same time, there is an error and the machine will stop. If neither of the magnets magnetize there is no punch in that column and there is no error. If both magnets magnetize at the same time, there are punches in identical rows of both cards in that column and there is no error. Any set of comparing magnets can be used as long as the corresponding sides of the set are wired to the corresponding columns being compared.

h. Summary Punch Cable

The summary punch cable is used to connect the reproducer with the accounting machine during the summary punch operation. *When it is not in use the cable must be disconnected and returned to the receptacle.*

3. Straight Reproducing (Foils 16, 17, 18)

In straight reproducing the reading and punching units are synchronized. The original deck is placed in the read hopper and the cards to be punched are placed in the punch hopper.

As a card is fed into the reproducing brushes in the read side, a card is also fed into the punch dies in the punch side. The card in the read side is "read" by the reproducing brushes and the same data is punched into the other card by the punch dies. The wiring necessary is from the reproducing brushes to the punch magnets.

To wire the comparing unit, the comparing brushes (read side) are wired to the top half of the comparing unit, and the punch brushes (punch side) are wired to the corresponding set of compare magnets hubs in the lower half of the comparing unit.

4. Gang Punching

a. One Master Card (Foil 19)

When gang punching with one master card, all the cards in the deck will contain the same data as the master card for the field that is gang punched. The master card contains the data that is to

be punched into all the following cards (detail cards). The punch side of the machine is used to punch the cards. The read side can be used to compare the cards after they are punched, but it is unusual to compare the gang punched cards with one master card.

The cards are placed in the punch hopper. The first card (master) passes under the punch dies and enters under the punch brushes; and at the same time the next card is entering the punch die station. The data in the master card is read and punched into the following card. After the second card has been punched, it is "read" by the punch brushes and that information is punched into the next card. The same process is followed until all the cards have been punched. The punch brushes are wired to the punch dies on the control panel.

The read side is used to compare the cards after they have been punched. The reproducing brushes are wired to one side of the compare unit and comparing brushes are wired to the other side of the unit. Comparing works in a similar manner as punching. The card at the comparing brush is compared to the card following it at the reproducing brush station.

b. Interspersed Gang Punching (Foils 19 and 20)

The same basic pattern of wiring is used to gang punch with either one master card or more than one master card (interspersed master gang punching). In addition to the wiring already described, it is necessary to add two wires to the control panel. One of these is from one of the Punch X-brushes to one of the PX hubs. The other wire is from one of the Read X-brushes to one of the RX hubs, if comparing is to be done.

Since there is more than one master card, it is necessary to suspend punching for one card cycle to allow the master card to pass by the punch dies without being punched. The Punch X-brushes "read" X-punches just before the cards enter the punch die station. This allows the master cards to be identified before they can be punched. The Read X-brushes perform the same function on the read side except they suspend comparing for one card cycle.

5. Emitters

(a) O-X Emitter

These four hubs produce on impulse at both 11-(X) and 0-time. These hubs may be used to add control punches or to increase the size of a field by adding O's. To punch an X or an O, it is necessary to use a column split, since the emitter gives out *both* impulses.

(b) Gang Punch Emitter

The gang punch emitter is a combination of 12 hubs. Each hub produces an impulse at the time one particular row is being punched. There is one hub for each punch position. The gang punch emitter is an optional feature on the 514.

6. Switches

a. Reproducing Switch

The reproducing switch synchronizes the reading and punch feeds. If either hopper empties, the machine automatically stops. This switch should be ON when both feeds are to be used to perform one operation and OFF when used independently, as in gang punching.

b. Selective Reproduce and Gang Punch Compare Switch

This switch allows the reading unit to feed continuously when it is ON. This switch should be ON only when a selective reproducing or a gang punch and comparing operation is being run.

c. Card X-Punch

This switch is used to identify which card contains the X-Punch in an interspersed master gang punching operation. If the master cards contain the X-punch, the switch should be in master position (up). If the detail cards contain the X-punch,

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the switch should be in the detail position (down).

B. Review Questions

1. What is the function of the reproducer? What are the four basic operations that it can be used to perform?
2. The read unit consists of what parts?
3. The punch unit consists of what parts?
4. What is the function of the comparing unit, and how does it operate?
5. What must be taken into consideration when more than one master card is used in the gangpunching operation?
6. What is a O-X emitter and a gangpunch emitter?
7. What is the purpose of the following switches?
   a. Reproduce switch
   b. Selective reproduce and gangpunch compare switch
   c. Card X-punch switch

C. Laboratory Problems

1. Gangpunch, problem IX-1
2. Straight reproduce, problem IX-2
3. Interspersed gangpunch, problem IX-3

DIVISION X: COLLATOR—FILE MAINTENANCE

A. Units of Instruction

1. Function of the collator

The primary purpose of the collator is to arrange cards in an orderly sequence and is therefore used to perform the file maintenance function as does the sorter. Unlike the sorter, the collator performs this function by the comparing of one card with another.

This section will deal with the IBM 85 numerical collator. Since most applications are numerical, this is probably the most widely used model. Another machine, the IBM 87, is an alphabetic collator.

2. Six basic operations

The collator can be used to perform six basic operations, but it is possible to combine several operations so that they are performed at once.

a. Selection

As was true with the sorter, selection is the removal of certain cards without disturbing the order of the remainder of the deck of cards. Factors which can be used to control the selection of cards are (1) cards with X-punches, (2) cards without X-punches, (3) the first card of a group, (4) the last card of a group, (5) cards with blank columns, (6) cards which are out of sequence, and (7) cards with a particular number.

b. Checking sequence

Sequence checking is used to determine if all the cards in a file are in correct order. This operation is often performed while other basic operations are being performed.

c. Merging

Merging is the combination of two files into a single combined file. Both files must have previously been arranged in sequence before the merging operation can begin.

d. Merging with Selection

Merging with selection is similar to the merging operation with the exception that cards in either file which do not have a corresponding card (equal number) in the other file, are selected out as the two files are merged. Cards may be selected from either or both of the two files. When the operation is completed there will be three groups which are composed of the merged cards and the selected cards from both groups.

e. Matching

Matching is the process by which cards of two separate files are compared to determine if there is a card or cards in one file for each card or cards in a separate file. The cards in both files must be arranged in sequence before the matching operation begins.

There can be four groups of cards when the matching operation is completed. These are the two groups which contain cards which match and the two groups of selected cards which do not match.

f. Blank—Column Detection

The machine has the ability to check cards for blank columns. When a blank column is found the cards stop feeding and a blank—column—detection light is turned ON. This operation can be combined with other operations.

3. Features of the IBM 85

a. Main Line Switch

The main line switch supplies power to the machine and is located on the right side of the machine.

b. Hoppers (Foil 21)

The 85 has two card feed units, which are located in the upper left-hand corner of the machine with one unit just above the other. The top unit is known as the secondary feed, and the lower unit is known as the primary feed. Each hopper will hold approximately 800 cards. Cards can be added while the machine is in operation provided there is at least an inch of cards remaining. The cards are placed in the hopper 9-edge face down.

When the last card feeds from either hopper the machine will automatically stop.

The cards from the secondary hopper pass one set of 80 brushes known as the secondary read. The cards from the primary hopper pass two sets of 80 brushes. The first set of brushes is the sequence read and the second set which the card passes is known as the primary read.

Each feed operates at 240 cards per minute. With both feeds operating simultaneously a maximum of 480 cards can be fed.

c. Pockets (Foil 21)

The 85 has four pockets that are numbered from right to left 1, 2, 3, and 4. The cards from either feed will *normally* fall into pocket 2 unless the machine is instructed by the control panel wiring to place the cards into another pocket. Cards from the primary feed can fall into either pocket ±1 or pocket ±2. Cards from the secondary feed can fall in pockets ±2, ±3, or ±4. When any of the pockets fill, the machine will stop automatically.

d. Operating Keys and Lights

(1) Start

The start key is used to cause cards to start feeding from the primary and secondary feeds. The key should be depressed for three card cycles before the machine will feed cards automatically.

(2) Stop

The stop key may be used at any time during an operation to stop cards from feeding.

(3) Run-out

The run-out key is used after the last card is fed from either hopper to move remaining cards in the machine into the proper pockets.

(4) Reset Key

The reset key is used to restart the machine after the blank column detection light or the error light is turned ON.

(5) Ready Light

The ready light indicates that the main line switch is ON. When cards begin to feed through the machine, the light is turned OFF.

(6) BCD 1 (Blank Column Detection 1)

Whenever a blank column is found in a field wired to the Blank Column Detection Entry One, this red light is turned ON.

(7) BCD 2 (Blank Column Detection 2)

This light is similar to BCD 1 with the exception that Blank Column Detection Entry Two is used on the control panel.

4. Control Panel Hubs (Foil 22)

The control panel for the 85 allows the machine to be used to perform many varied operations. This section will deal with the basic fundamentals of control panel wiring. These examples should cover most of the collating operations which are used. Those who must go beyond these examples should consult the reference manual. (IBM 85 and 87 Collators)

a. Secondary Read (C-F, 1-20)

These exit hubs supply impulses which are picked up by the secondary read brushes. There is one hub for each of the 80 secondary read brushes.

b. Sequence Read (AE-AH, 1-20)

These exit hubs are used to supply impulses from the 80 sequence read brushes. This set of brushes is the first of two sets in the primary unit.

c. Primary Read (U-X, 1-20)

These exit hubs give off impulses from the 80 primary read brushes. The primary read brushes are the second set of brushes in the primary unit.

d. Blank Column Detection

These hubs are used to check for unpunched (blank) columns. There are two

units called Entry One (G-H, 1-8) and Entry Two (Y-2, 1-8). Each unit has eight positions which are standard and eight positions which are optional.

The DI (direct impulse) hubs (G-H, 20 and Y-2, 20) emit an impulse on all cycles and are wired to the unused blank column detection hubs.

The BCD CTRL (Blank Column Detection Control) hubs (S and T, 23-25) are used to control the two units. The S and P (Secondary and Primary) hubs (S-T, 25) must be wired to the proper hubs for each unit (S, 23 and 24 for unit one and T, 23 and 24 for unit two).

e. The Selector Unit

The selection unit is used for a large number of operations performed on the collator. The unit allows cards to be compared by 16 sets of electro-magnets. Since one position is used for each column, up to 16 positions can be compared.

The impulses from the secondary cards are normally wired into the Secondary Selector Entry (J, 1-16) and impulses from the primary cards are wired into the Primary Selector Entry (AA-AB, 1-16). (If blank column detector is used, the impulses may have been wired through the common hubs of these units.)

The selector unit will cause impulses to be given from one of the three sets of Selector Control Exits as a result of the compare. When the secondary number is lower than the primary number an impulse is emitted by the common Low Secdy (Low Secondary) hubs (A, 23-26). If the two cards are equal an impulse will be given off by the common Equal hubs (B, 23-26). If the primary card is low, the impulse will be available at the common Low Pri (Low Primary) hubs (C, 23-26).

f. Sequence Unit (Foils 22 and 23)

The sequence unit allows the cards from the primary feed to be checked for correct sequence. The card which is read by the sequence brushes is compared with the card read by the primary brushes. The Primary Sequence Entry (AC, 1-16) provides for 16 positions to be checked for sequence. The impulses are supplied from the Primary Read. (These may be wired through the selector unit or the blank column detection.) The Sequence Entry (AD, 1-16) provides for impulses from the Sequence Read to be compared. An impulse will be emitted by one of the three Sequence Control Exits as a result of the comparison of the two cards. If the card at the sequence read is higher than the number in the corresponding field of the primary read, an impulse will be given off by the common High Seq (High Sequence) hubs (D, 23-26). If the two cards are equal an impulse will be given off by the common Equal Seq (Equal Sequence) hubs (E, 23-26). If the card at the sequence read is lower than the card at primary read, the common Low Seq (Low Sequence) hubs (F, 23-26) will emit an impulse.

g. Functional Entries

(1) Secdy Sel

The Secondary Selection hubs are used to select secondary cards into pocket #2 (A, 41-42) or pocket #3 (A, 43-44).

(2) Pri Sel (B, 41-44)

The Primary Selection hubs are used to select primary cards into pocket #1.

(3) Pri Eject (D, 41-44)

The Primary Eject hubs are used to cause a primary card to eject while all other primary cards do not move.

(4) Pri Feed (E, 41-44)

The Primary Feed hubs cause a primary feed cycle to occur.

(5) Error Stop (F, 41-44)

The error stop hubs cause cards to stop feeding and the error light to be turned ON.

h. Basic set-up switches

The basic set-up switches are normally wired ON for most collating operations. The center hub and the hub to the right are connected to turn the switch ON.

(1) Sec (L, 23-25)

The Secondary Feed Switch emits an impulse as the result of a low secondary compare by the selector units and causes another card to feed.

(2) Ej (M 23-25)

The Eject switch emits an impulse when the number in the primary side of the selector unit is equal or lower than the number in the secondary side. This causes the primary card to be ejected.

(3) Pri (N, 23-25)

The Primary Feed switch causes feeding whenever the primary card is equal or lower than the secondary card.

(4) MSS (P, 23-25)

The Multiple Secondaries and Selection switch is wired on whenever there are two or more secondary cards with the same number in the control field.

(5) Inlk (Q, 23-25)

The interlock switch is wired so that selection will take place normally when the last cards pass through the collator.

(6) Pri Chg. (R, 23-25)

The Primary Change switch is used in connection with the other set-up switches to help them perform their functions.

i. CTRL INP

The Control Input hubs (U-V, 23-25) are normally wired to the Sel (Selection) hub (V, 24) and the Seq (Sequence) hub (V, 25) to cause the selection and/or the sequence units to test the comparisons and emit impulses to the functional entries.

j. Restore (W-X, 23-26)

These switches cause the machine to clear the two sides of the selector and sequence units. The S, P, PS and Seq hubs (W, 23-26) are wired to the three P (primary) restore hubs (X, 24-26) and the S (secondary) restore hubs (X, 23) which are directly underneath. Normal wiring practice is to wire these hubs although it may not be mandatory for the particular operation.

5. Control Panel Wiring (Foil 22)

a. Checking Sequence

(1) Operation

Sequence checking is performed by the primary feed only on the 85. The sequence can be checked for either ascending or descending order. The operation involves the comparison of one card with the following card by the use of the sequence unit. If cards are found to be out of sequence the machine can be wired to stop.

(2) Wiring

The card columns to be compared for sequence are wired from the sequence read (AE-AH, 1-20) to the sequence entry (AD, 1-16) and from the primary read (C-F, 1-20) to the primary sequence entry (AC, 1-16). The sequence control exits (D-F, 23-26) will give off impulses according to the results of the compare; high sequence (D, 23-26), equal sequence (E, 23-26), low sequence (F, 23-26). The set of hubs which represents the error condition should be wired to the error stop hubs (F, 41-44). The error condition will depend upon the sequence of the cards and the nature of the job being performed. When cards are in ascending order the low sequence hub (F, 23-26) is wired to error stop (F, 41-44). All of the

basic set-up switches (L-R, 23-25), Control inputs (U-V, 23-25) and the restore hubs (W-X, 23-25) should also be wired ON.

b. Blank Column Detection

Blank column detection can be wired for either or both of the card feeds. The secondary read is normally wired to unit one (G-H, 1-8) and the primary read is wired to unit two (Y-Z, 1-8). The common hubs for each unit allow the impulses to be wired to other units such as the selector and sequence units. The remaining hubs of each unit which are not to be used should be wired to the Direct Impulse hub (G-H and Y-Z, 20) to prevent false indications of blank columns. The blank column detection control switches (S-T, 21-25) should be wired ON with the S (secondary) and P (primary) hubs wired for the appropriate units which are used.

c. Merging

The secondary read (E-F, 1-20) for the field to be selected is wired to the secondary selection entry (J, 1-16), and the primary read (U-X, 1-20) is wired to the primary selector entry (AA—AB, 1-20). (Both the secondary and/or the primary read may be wired through the blank column detection units. If the sequence checking is desired, the impulses from the primary read should be carried into the primary sequence entry.)

All of the basic set-up switches (L-R, 23-25), control input (U-V, 23-25) and restore hubs (W-X, 23-25) should also be wired ON. If the sequence unit is used to check sequence, low sequence (F, 23-26) should be wired to error stop (F, 41-44).

d. Merging With Selection

The merging with selection operation is similar to the wiring for merging with the exception that it is necessary to select cards from either feed which do not have an equal number in the corresponding file. To the wiring which has been described in the merging section, the low primary hub (C, 23-26) should be wired to the primary selection hub (B, 41-44). The low-primary impulse will cause the primary cards with no match to be selected into pocket one. In addition, secondary cards with no match should be selected by wiring, low secondary (A, 23-26) to secondary select. Either pocket three (A, 43-44) or pocket four (A, 41-42) can be used to select the secondary cards.

e. Matching

In the matching operation, unlike the merging with selection operation, cards with an equal number are not merged into one file, but are kept in separate groups. In addition to the wiring already described in the merging and merging with selection sections, it is necessary to wire the equal hubs (B, 23-26) to secondary select 3 (A, 41-42). The equal impulse will cause matched cards to fall in pocket number 3. Low secondary should be wired to secondary select 4 (A, 43-44) to cause secondary cards without a match to fall into pocket number 4.

B. Review Questions

1. For what function is the collator used?
2. List and define the six basic operations of the collator.
3. Describe the two card feed units of the 85. How are cards inserted into the machine?
4. Into which pocket will cards *normally* fall? What other pockets can the cards for each unit fall?
5. What is the purpose of the following keys and lights?
   a. Start
   b. Stop
   c. Run-out
   d. Reset
   e. Ready light
   f. BCD
   g. BCD2

6. What is the purpose of blank column detection? Explain how it is wired.

7. What are three possible results from comparing two cards in the selector unit (selector control Exits)? How many positions can be compared?

8. What is the sequence unit and how is it used? What is the purpose of the sequence control exits?

9. What is the result of impulsing the following functional entries?
   a. Secy Sel
   b. Pri Sel
   c. Pri Eject
   d. Pri Feed
   e. Error Stop

10. Describe the wiring for matching, merging, and merging with selection.

C. Laboratory Problems

1. Merging, problem X-1
2. Matching, problem X-2
3. Merging with selection, problem X-3

DIVISION XI: INTRODUCTION TO THE ACCOUNING MACHINE

A. Units of Instruction

1. Features of the 402 Accounting Machine

a. Purpose

The purpose of the 402 Accounting Machine or tabulator is to print reports from punched cards by means of control panel wiring.

b. Speed

Information is printed at a rate of 50 to 150 cards a minute. The 402 prints only one line of information from each card at any given time. The full-speed 402 tabulator lists at the rate of 100 cards a minute and tabulates (lists a single total for a group without listing the individual items) at the rate of 150 cards a minute. The "Series 50" machine operates at the rate of 50 cards per minute for both listing and tabulating.

c. Print unit (Foils 24 and 25)

The print unit records information on the report form. This unit consists of two sections of typebars divided by a ribbon guide. The alphamerical section on the left may contain a maximum of 43 typebars, each having all 26 alphabetic characters, the numbers 0 through 9, and a special character position which contains the ampersand (&) character. The numerical section on the right may have a maximum of 45 typebars, each containing the numerals 0 through 9, the asterisk symbol on odd-numbered typebars, and the credit symbol on even-numbered typebars. The standard 402 tabulator has 88 typebars consisting of 43 alphamerical and 45 numerical typebars. Some machines have 73 typebars consisting of 43 alphamerical and 30 numerical typebars. Other machines have only 55 typebars consisting of 25 alphamerical and 30 numerical typebars. Alphabetic information can be printed only on the left side of the machine, but numeric data may be printed with any typebar. The ribbon guide takes up a space the width of one typebar. Each typebar has a hammer that fires after all typebars have been positioned, forcing the typebar character against the paper. The 402 uses the parallel method of printing in which the entire line is printed at one time. Typebar positioning will be included in Division II.

d. Card feed hopper

The hopper may hold 800 to 900 cards. Cards are placed in the hopper face down, nine-edge toward the throat of the machine. The machine stops when the data from the last card has been printed, but the last three cards will still be inside the machine and must be moved into the card stacker by pressing and holding down the start key. A card weight should always be placed on top the card deck in the hopper.

e. Card stacker

The stacker may stack up 1,000 cards face forward, nine edge down. When the stacker becomes full, a toggle-type switch can shut off the machine.

f. Control panel

The control panel contains the external wiring that gives the machine its versatility in printing, summarizing, and spacing. The control panel is of the same general type used in the reproducer and interpreter and contains exit hubs (emit impulses) and entry hubs (accept impulses). The hubs will be explained in the other divisions. The control panel is inserted in the rack located at the left of the machine, and the handle must be placed in the down position so the panel will make contact with the prongs or springs in the machine. Wires should not be inserted or removed while the panel is in position because damage to the prongs may result, causing machine malfunction. (Show a control panel)

g. Operating switches and signals

The *main line switch* is located on the right beneath the reading table and must

be turned on to give the machine the electrical current by which it operates.

The *start key* is depressed to start the feeding of cards into the machine and to run the cards into the stacker after the machine stops.

The *stop key* may be pressed to stop cards from feeding from the hopper.

The *final total key* is depressed to print a final total.

The *unlabeled red light* goes on when the main line switch is turned on and the machine is idling.

The *stop light* comes on whenever the machine stops because of an impulse received by a machine stop hub on the control panel.

The *fuse light* goes on whenever a fuse burns out.

The *form light* goes on when the last form is within 10 inches of the platen if the form stop device is made operative by positioning the lever at the left side of the carriage.

The *card feed stop light* goes on if a card fails to feed from the hopper.

2. Demonstrate the machine to the class by running a listing to illustrate printing.

3. Form Layout
The form layout at the bottom of the wiring chart is used to plan the printing of the report. Printing positions are indicated by either placing an x mark in the typebar positions of a print field or marking off print fields by drawing vertical lines from the Report Headings line through the Class of Total line. The report headings and card field headings are printed over the print field, and the card columns used are included. Hammerlock or hammersplit levers that are used are indicated by an x mark.

B. Laboratory—402 demonstration

DIVISION XII: DETAIL PRINTING

A. Units of Instruction

1. Numerical printing

   a. Path of the card (Foils 26 and 27)

   The 402 has two sets of brushes, labeled second and third reading. The cards are placed in the hopper face down, 9-edge toward the throat. The cards move from the hopper, past the 80 second reading brushes, past the third reading brushes, and into the stacker. Each of the 80 card columns "is read" by one of the 80 third reading brushes. The card moves past the brushes one row at a time. When a hole is sensed in the card (by the brush's dropping through and making contact with an electrically charged roller), an impulse travels over internal wiring to the hub on the control panel labeled third reading, and corresponding to the card column in which the hole is punched. The impulses are used to move the typebars to cause printing.

   b. Third reading (Foil 44)

   There are two sets of third reading hubs, each containing 80 hubs, (O-P, 1-40; DD-EE, 1-40). Both sets can be used interchangeably, although the lower set is more often used when using counters or co-selectors.

   c. Normal alphamerical print entry (Foil 44)

   These hubs (Q, 1-43) correspond to the 43 typebars on the left side of the full complemented machine.

   d. Numerical print entry (Foils 44 and 28)

   These hubs (R, 1-44; S, 44) correspond to the 45 typebars on the right side of the machine. Both types of print entry hubs will accept impulses from the third reading brush hubs. The print entry hubs are connected internally to the corresponding typebars. The numerical typebar moves up one number as the card moves one row past the third reading brushes. The typebar stops moving when it receives an impulse resulting from a punch in the card column that is to be printed.

   e. List (Foil 44)

   All the typebars rise every time a card passes the third reading station if one of the List hubs (Z, 41-42) are impulsed. Hammers will cause the typebars to print if the card columns contain punches and the list hub is impulsed from an all cycles hub.

   f. All cycles (Foil 44)

   These ten hubs (HH, 41-50) emit impulses on every machine cycle, including those cycles when the cards are not moving. As indicated above, to list data from every card, the list hub must receive an impulse from an all cycles hub.

2. Alphabetic printing (Foils 44 and 29)

   An alphameric typebar must be impulsed from both the zone punch and the digit punch in the same column when printing letters. Each alphamerical typebar has a zone group selector which must be positioned.

   a. Normal zone entry (Foil 44)

   These hubs (L, 1-43) accept only zone impulses. An impulse (0-12) received by these hubs positions the zone group selector of the typebar. The typebar starts moving when it receives a 0-12 zone impulse and stops at 12 time. When a zone impulse is absent, the typebar will print a number.

   b. Second reading (Foil 44)

   The 80 second reading brush hubs (M-N, 1-40) read all 80 columns of the card. The zone group selector must be impulsed before the digits impulse the typebar; therefore, the normal zone entry hubs must be impulsed from second reading.

   c. Normal alphamerical print entry (Foil 44)

   These hubs (Q, 1-43) correspond to the typebars that contain all 26 alphabetic characters, the numbers 0 through 9, and a special character position which contains the ampersand character (&).

d. Third reading (Foil 4-4 and 29)

These hubs (O-P, 1-40; DD-EE, 1-40) are connected internally to the third reading brushes. When the card is at the third reading station, the typebar begins moving at 9 time and stops whenever it receives an impulse from a hole punched in the card. The movement of the typebar is synchronized with the reading of the card.

3. Hammersplit levers (zero suppression)

The machine is engineered to print up to twelve preceding zeros automatically on the numeric side following a significant digit or until it comes to another significant digit unless hammersplit levers are raised. There is a hammersplit lever for each typebar. When a hammersplit lever is raised, zeros from the position to the right of the lever up to the next significant digit or special character are suppressed. Therefore, on the numeric side of the machine, it is usually desirable to raise a hammersplit lever on the low-order position of each field and at each special character position.

The printing of zeros is different on the two sides of the machine. An understanding of when zeros will print is important in order to know when to set hammersplit levers.

a. Alphamerical typbars

These typebars print zeros only

1) if the zero is punched in the card or present in the counter,

2) if the position is wired to a typebar, *and*

3) if there is a significant digit or character to the left of the zero.

b. Numerical typebars

Zeros up to 12 are printed by unwired typebars to the right of any significant digit. The raising of hammersplit levers will remove wired zeros; but, of course, a zero appearing in a number will print.

4. To explain the use of the 402 to print an alphabetic and numeric report use a report similar to that shown on page 12 of the *IBM 402 Accounting Machine Manual of Operation* (Form number A224-5654)

B. Laboratory

1. Numerical listing, problem XII-1

2. Alphabetic and numerical listing, hammersplits, problems XII-2 and XII-2A

DIVISION XIII: ADDITION

A. Units of Instruction (Foil 30)

1. One of the functions of the 402 is accumulation. The 402 adds by means of counters, which are a series of wheels with numbers 0-9 similar to a speedometer. A number and letter indicate the size and group of a counter. An 80-counter machine has four 2-position, four 4-position, four 6-position, and four 8-position counters. The groups are A, B, C, and D. (Show panel diagram) On machines having only 56 counter positions, counters 4C, 4D, 8C and 8D are not operative.

2. Four basic steps in addition
   a. What information is to be accumulated? (Counter entry)
   b. Which cards are to be added? (Counter control)
   c. Where should the data and total be printed? (Counter exit to typebars)
   d. When should the total be printed? (Counter read-out and reset)

3. Counter Entry

   These counter entry hubs (Z-CC, 1-40) accept information to be added in a counter. The counters usually receive numerical data to be added when cards are at the Third Reading station. A connection must be made on the Control Panel from Third Reading hubs to the Counter Entry hubs of the appropriate size counter. Each Counter Entry position has two electrically common hubs, either of which may accept impulses from a Third Reading hub. The counter number chosen must be large enough to hold the total of all the numbers entered. The lower order position of the counter is wired first. (Illustrate on a panel diagram)

4. Counter Control (Foil 44)

   A counter will add the data it receives only if it receives an instruction (an electrical impulse) to do so. The Counter Control Plus hub (S-T, 51-66) of the chosen counter must be impulsed. The Card Cycles hubs (J-Q, 49-50) emit impulses on every card feed cycle, and may be used to impulse Counter Control Plus. Hubs J-N, 49 are available on every card cycle. Hubs O-Q, 49 and J-Q, 50 are not available when head control is wired.

5. Print (Foils 44 and 31)

   Each counter entry has a corresponding counter exit (S-V, 1-40) from which detail and total printing is obtained. The Counter Entry hub is internally wired to send data to the counter, and the counter sends data to the Counter Exit hub. When the Counter Exit hub receives an impulse from the counter, it sends an impulse to a print entry hub, if wired. The lower order position of the counter is wired to the lower order position of the print field. Be sure to wire enough positions to take care of the totals.

6. Totals

   Each counter has a p[illegible] of common total entry hubs (GG-HH, [illegible]-66), which when impulsed will cause th[illegible]ounter to read out (print the total) and c[illegible]ar (reset to zero).

   There are three Fin[illegible] Total exit hubs (BB, 42-44), each independent of the other. These hubs emit an impulse when the final total key and start key on the machine are depressed if the machine is idling, if the hopper is empty, and if the last card is in the stacker.

   To cause spacing before a final total, wire from a Final Total hub to Space Control 1 for a single space, 2 for a double space, or 3 for a triple space. (AA, 42-44)

7. Method of addition

   When a brush reads a punched hole, the counter wheel starts moving and continues to move one position for each row (9-0) of the card left to be read. When the zero position of the card is reached, the counter wheel stops moving.

   The List hub must be impulsed from All Cycles in order to list every card; otherwise, only the totals will print.

8. Diagram and explain the last column of figure 13, page 19 of the *IBM 402 Manual*.

B. Laboratory Problems—XIII-1

DIVISION XIV: PROGRAM CONTROL

A. Units of Instruction

1. Meaning and function of program control (Foils 44 and 32). The 402 can add data, print subtotals, then add all the subtotals and print a final total.

   A total for each individual customer's sales is a minor total compiled from a minor group. The machine can distinguish between the cards of one minor group from the cards of another, since the 402 is able to compare two cards at a time. A change in customer number or name is a signal to the counters to print a minor total. This signal occurs when the last card of one minor group reaches the Third Reading station. One card read at the Second Reading station is compared with the other read at the Third Reading station. Comparing magnets are wired to hubs called Comparing Entry hubs (G, J, 25-44). A wire from each reading station must be wired to each Comparing Entry row. If the fields are punched the same, indicating the same program group; then the machine continues to feed cards. If the panel is properly wired and an unequal comparison occurs, the machine will start a total program cycle. In order to start a total program when there is a difference in any column of the field, all but the leftmost hub (I, 25) must be connected in a line. (Illustrate with a panel diagram) If an unequal comparison results, the exit emits an impulse. When the difference is detected by the Comparing Entry, an impulse from the last Comparing Exit hub in the line may be used to operate the Minor Program Start (P, 45). When the Minor Program Start hub receives an impulse, the Minor Program hubs (CC, 44-50) will be activated one cycle later. An impulse from any Minor Total Program hub to Counter Total will cause the counter to readout and reset to zero. The comparing units operate in much the same way as those of the 514 Reproducer. (Foil 9)

2. Asterisk printing (Foil 44)
   An asterisk may be printed from odd-numbered numerical typebars by wiring one of the asterisk-symbol exit hubs to numerical print entry. Hub F (BB, 41) emits an impulse on final totals; hub 1 emits an impulse on minor totals; hub 2, on intermediate totals; and hub 3, on major totals. An asterisk symbol may also be printed from the "10" hubs.

3. Diagram and explain the minor total portion of figure 17, page 24, of the *IBM 402 Manual.*

4. Intermediate totals and major totals (Foil 44)
   Intermediate totals are totals of minor totals, and major totals are totals of intermediate totals. In figure 17, page 24 of the *IBM 402 Manual,* the minor group has the sub-ledger number, the intermediate group has the general-ledger number, and the major group has the department number. Intermediate and major programs may be started by comparing also. Wiring for these programs is similar to wiring for a minor program. When the intermediate program start is impulsed, a minor total cycle is taken before the intermediate total cycle. The major program also forces a minor total cycle and an intermediate total cycle before the major cycle. The forcing of cycles is necessary because the minor control group numbers in two intermediate groups might be identical. The minor counters must also total and reset to zero when the intermediate program cycle is taken.

   To obtain minor, intermediate, and major totals, wire from third reading to the counter entry hubs of the minor counter. Connect the other common counter entry hubs of the minor counter to the intermediate counter entry hubs and the other intermediate counter entry hubs to the major counter entry hubs. The counter exit hubs of each group are connected to the typebars. The minor, intermediate, and major counters are all impulsed to add on every card (card cycles). The minor counter totals by wiring a minor total program exit to counter total. Intermediate and major program exits are used to total the intermediate and major counters. To prevent the intermediate and major counters from listing the amounts from every

card, the exits of these counters must be suppressed on card cycles. (Wire card cycles impulse to Y-Z, 51-66 or counter exit suppression of the intermediate and major counters.

5. Complete the diagram (figure 17, page 24 of the *IBM 402 Manual*) for the intermediate and major programs.

6. Program control—alphabetic fields
   Wiring to compare alphabetic fields can be done. If the field is to be printed, split wires are needed because only one set of second reading hubs is available. One second reading wire goes to the comparing entry hub and the other goes to normal zone entry.

B. Laboratory Problems

1. Minor totals, problem XIV-1
2. Minor, intermediate, and major totals, problem XIV-2

DIVISION XV: PILOT SELECTORS AND SUBTRACTION

A. Units of Instruction

1. Selectors (Foils 33, 34, and 35)

   The selectors operate basically the same way as the selectors on the interpreter and reproducer. A selector is a device with a two-position switch and a magnet, which is a piece of iron with a wire wrapped around it. When current flows through the wire, the magnet is turned on and the switch-lever is pulled to the upward T (transferred) hub position. A connection is made between the C (common) hub and the T (transferred) hub. When no current flows, the magnet is off; and the lever drops to make a connection between the C (common) hub and the N (normal) hub.

2. Pilot selectors (Foils 44 and 33)

   The 402 may have 16 two-position pilot selectors (E-M, 51-66), with 11 standard on a 80-counter machine. The two positions are vertically arranged, each position having a C (common), a N (normal), and a T (transferred) hub. (Illustrate with panel diagram) Each selector has three pickup hubs—X, D, and I. Only the X-pickup will be considered at this time. If a card column containing an X-punch is wired from the second reading station to the X-pickup of a pilot selector, one cycle [illegible] card is at the third reading st[illegible] will be made between the [illegible] transferred hubs. The absence of an X-punch in the particular card column will keep the connection between the normal and common. Because the selector transfers on the following cycle, the card column containing the X-punch must be read by the second reading brushes. The selector drops out at the end of the following cycle or when the card has been read at third reading.

3. Uses of pilot selectors

   Pilot selectors are used to control certain individual functions; for example, listing, controlling co-selectors, and controlling addition and subtraction. The use of pilot selectors to control addition and subtraction is described in the following section.

4. Addition and subtraction with pilot selectors (Foils 21 and 13) In accounting, there are often credits which must be subtracted from a total. Subtraction is accomplished by impulsing one of the two common Counter Control Minus hubs of the particular counter (U-V, 51-66) from Card Cycles. If credit cards contain an X-punch in a particular column, these cards may be subtracted (while normal cards are being added) from the total by using a pilot selector. A card cycles impulse is necessary for both addition and subtraction; therefore, a car cycles hub must be wired to the common portion of the pilot selector. The presence of an X-punch in the card will energize the magnet and connect the common and transferred hubs; therefore, the transferred hub should be connected to the Counter Control Minus hub of the counter used and the impulse would travel from the card cycles hub to the pilot selector common, out the transferred side of the selector, and to the minus hub. All cards without an X-punch will be added when the impulse flows from card cycles to the common hub, to the normal hub, and to the counter control plus hub of the counter used.

5. Net balance subtraction (Foil 44)

   The 402 subtracts a number in a counter by adding the nine's complement of that number. A net balance machine converts complements to true figures before printing at total time. In the example 8 − 3, the nine's complement of 3 is 6; 6 added to 8 is 4 and one to carry. The carry must be added to the 4 to get the correct answer of 5. The CI and C hubs (DD-EE, 51-66) are used for the carryback from the left position of a counter to the units position of the same counter. Wire CI to C for the counter used.

   If 8 had been subtracted from 3, the answer would have been minus 5. The nine's complement of 8 is 1; 1 added to 3 is 4. Since there is no carry, the result is not a true figure and must be recomplemented (9 minus 4 is 5) and prefixed by a minus sign (−5 or 5 CR). The Negative Balance Test

Exit hub (AA, 51-66) for the counter emits an impulse when the counter is negative on a total program cycle. The counter is considered negative if a nine is present in the left position of the counter. Each counter also has two common Negative Balance Control hubs (BB-CC, 51-66), which, when impulsed from the Negative Balance Test Exit to cause a complement figure (4) to be converted to a true figure (−5) before printing the total. In the following illustration, 08 is subtracted from 03 in a two-position counter. The complement of 08 is 91. When 03 and 91 are added, the counter shows 94. Because a 9 occupies the left position of the counter, the Negative Balance Test Exit emits an impulse that goes to the Negative Balance Control hub (if wired) and causes the 94 to be converted or re-complemented to 05 CR.

Each counter has a credit symbol exit hub (FF, 51-66), which emits a ten-timed impulse when a figure is subtracted (Counter Control Minus hub is impulsed) or a total is negative. The CR Symbol Exit is wired to any even-numbered numerical typebar.

6. Method of subtraction
   The counter wheel turns in the same direction for subtraction as for addition. To add the complement of a number, the counter wheel advances one position for each card row read and stop when a punched hole is sensed. In addition, the counter wheel advances one position for each card row after the punch in the card column has been sensed and stops when the zero row of the card has been read at third reading.
7. Diagram and explain the wiring for the Commission Amount column in figure 23, page 32 of the *IBM 402 Manual*.

B. Laboratory Problem

Subtraction, problem XV-1.

DIVISION XVI: DIGIT AND X SELECTION

A. Units of Instruction

1. Digit selectors—definition and function (Foils 44, 37, and 38)

   A digit selector is a device that separates the impulses that come into it and allows the machine to detect particular impulses. If an impulse from a six punch went into the selector, the impulse would come out only at a six exit hub. There are two digit selectors, A and B. These are optional features with most machines having A. Each selector (A-D, 45-57) has a pair of common (C) entry hubs and a pair of common exit hubs for each digit (9-0, 11, 12). Any of these digit exits may be wired to D-pickup hubs of pilot selectors and will function in the same way as an X-punch wired to the X-pickup. A second reading brush is wired from the card column containing the control punch to the C-hub of the digit selector. If the machine is to be controlled by an eight-punch, the eight-exit hub is connected to the D-pickup hub of a pilot selector. Only an eight-punch would cause the selector to transfer on the following cycle and to remain transferred until all rows of the card have been read at the third reading station. If any digit were sufficient for selection, wiring could be between a second reading brush and the D-pickup hub of the pilot selector. The D-pickup will accept any 9-12 timed impulse while the X-pickup will accept only X or 12 impulses.

2. Digit emitting (Foil 44)

   The DI (Digit Impulse—K, 44) emits an impulse for every digit 9 through 0 and for 11 and 12 on every machine cycle. When wired into the C hub of a digit selector, all digit exits emit impulses on card feed cycles. Use an illustration similar to figure 29, page 39 of the *IBM 402 Manual.*

3. X selection—purpose (Foils 13 and 15)

   A pilot selector can be used to separate X from NX (no X) cards. The pilot selector transfers on a X card so that the impulse wired into the common of the selector will be available out the transferred when a X card comes through and out the normal side when a NX card comes through. Amounts for different types of transactions—sales and returns—may be punched in the same card field but added in separate counters by using X (or digit) selection. Diagram and explain the wiring for figure 26, page 36 of the *IBM 402 Manual.*

   Selectors may be used to detail print some cards and group print other cards. This will be explained later. (See page 39 of the *IBM 402 Manual*)

B. Laboratory Problems

1. Digit selection—problem XVI-1
2. Digit emitter and X selection—XVI-2 and XVI-2A

DIVISION XVII: GROUP INDICATION

A. Units of Instruction

1. Meaning and purpose of group indication

   Group indication is the printing of certain repetitive information from only the first card of a group when detail printing. (See figure 38, page 46 of the *IBM 402 Manual*)

2. First card impulses (Foil 44)

   The First Card Minor, Intermediate, and Major hubs (M, 41-43) emit impulses during the print cycle of the first card of their respective program groups.

3. Selector method (Foil 44)

   Selectors may be used to control group indication. Co-selectors work like other magnetic switches. Each co-selector has five positions, and each position has a common, normal, and transferred hub (W-Y, 1-40). Each selector has two common pickup hubs (A-D, 58-66), which when impulsed cause the selector to be transferred immediately for the remainder of the cycle. To use a co-selector for group indication, the card field is wired from the third reading brushes to the common hubs of the selector and from the transferred hubs to the print entry. The selector is picked up by wiring the first card impulse of the appropriate program group to the co-selector pickup hub. Program start must be impulsed from the comparing units. A review of the three program levels might be necessary at this point. (See Division IV.)

4. Hammerlock method (Foil 44 and 39)

   Each typebar has two hammerlock levers. The short lever, when raised, prevents the hammer from striking the typebar and printing. The long hammerlocks when raised are controlled by the hammerlock hubs on the control panel (A, 41-44). When these hubs receive an impulse, the hammers do not fire on the typebars for which the long hammerlocks are raised. The D pickup hubs (A, 41-42) receive impulses to control hammerlocking on the following cycle. The I (immediate) pickup hubs receive impulses to control hammerlocking on the same cycle. *All typebars are subject to hammerlock control from a single impulse.*

   To use the hammerlock method to control group indication, the card field is wired from the third reading brushes to print entry, and the long hammerlocks corresponding to the typebars used are raised. The first card impulse of the appropriate program group is wired to the immediate pickup of a pilot selector. A card cycles impulse is wired to the common hub of the pilot selector, and the normal hub is wired to one of the immediate hammerlock pickups. For every program change of the particular group, the pilot selector will be picked up, causing a break in the connection between the card cycles hub and hammerlock hub and allowing the information to print. The hammerlock method is the easiest to use for the group indication of alphabetic data.

5. Counter method

   The card field is wired from the third reading brushes to counter entry of a particular counter. The counter exits are wired to print entry. The first card impulse is wired to counter control plus; therefore, printing will occur only for the first card of a program group.

6. Diagram and explain the wiring for figure 18, page 46 of the *IBM 402 Manual*.

B. Laboratory Problem

1. Group indication—problem XVII-1

DIVISION XVIII: GROUP PRINTING AND SETUP CHANGE

A. Units of Instruction

1. Meaning of group printing (Foil 40)

   Group printing is the printing of accumulated data instead of listing data from every card. The list hub is not impulsed when group printing. If program start is not wired, the typebars rise only when the final total key is depressed. If program start is wired, the typebars rise to print the first card of each group for group identification and to print the total of each group. Unless the counter exit is suppressed, the amount of the first card will print; and the accumulated total will print over this first card amount.

2. Setup change

   Setup change allows the use of one panel for several different reports without changing panel wires. Each setup change switch has a hub on the control panel, which emits an impulse each machine cycle when the switch is on. The setup change exit hub may be wired to the immediate pickup hub of a pilot selector. (Illustrate by using a panel wired to group and detail print.) An all cycles impulse wired through the normal side of the selector to the list hub will be blocked when the switch is turned on. A card cycles impulse is wired through the other transferred selector position to counter exit suppression (Y-Z, 51-66) to suppress the printing of the first amount in each program group when group printing. If the counter exit is not suppressed when group printing, the accumulated total will print over the first card amount.

3. Diagram and explain the wiring in figure 41, page 48 of the *IBM 402 Manual*.

B. Laboratory Problems

1. Group printing—problem XVIII-1
2. Setup change—problem XVIII-2

DIVISION XIX: TOTAL TRANSFER

A. Units of Instruction

1. Purpose

   The method of total transfer is used to check the accuracy of totals. If the three counters used for minor, intermediate, and major totals are connected entry to entry by using the common counter entries (See Division IVA4), one counter total could be incorrect and the major total could be correct. If the total transfer method is used, a correct major total (or final total if four classes of totals are used) assures the accuracy of the other totals. Total transfer is also used to print as many as four levels of totals from the same typebars.

2. Total printing from the same typebars (Foil 44)

   A separate counter is used for each group total, but only the minor counter adds and subtracts from the card. The minor total prints and transfers to the intermediate counter on a minor program change. The intermediate total prints and transfers to the major counter on an intermediate program change. The major total prints and can be transferred to a final counter on a major program change. The final total prints when the final total key is depressed after all cards are in the stacker.

   The third reading brushes are wired to the minor counter entry. The minor counter exit is wired to print entry and to the intermediate counter exit. The intermediate counter exit is wired to the major counter exit. (Any of the counter exits could have been wired to print entry.) *Data can enter the counter at either the counter entry or the counter exit* as long as the counter control plus or minus hub is impulsed. The minor counter is controlled by card cycles wired through a pilot selector to counter control plus or minus. The carry exit and carry entry and negative balance test exit and negative balance control must be wired for each counter used if subtraction is a possibility. Counter total minor, intermediate, and major must be impulsed from the minor, intermediate, and major program exit hubs. The final counter total must be impulsed from a final total hub.

3. Transfer and S.P.X. control plus and minus (Foil 21)

   Only minor total must enter the intermediate counter, only intermediate totals must enter the major counter, and only major totals must enter the final counter. The intermediate, major, and final counter controls must be impulsed at total time instead of during a card cycle. The Transfer and S.P.X. Control Plus and Minus hub (W-X, 51-66) of a counter emits an impulse when the total hub of the same counter is impulsed. The transfer plus hub of the minor counter is wired to the counter control plus hub of the intermediate counter, and the transfer plus hub of the intermediate counter is wired to the counter control plus hub of the major counter. The transfer minus hub of the minor counter is wired to the counter control minus hub of the intermediate counter, and the transfer minus hub of the intermediate counter is wired to the counter control minus hub of the major counter. The transfer plus and minus hubs of the major counter must be wired to the counter control plus and minus hubs of the final counter if a final total is needed.

4. Diagram and explain the wiring for figure 43, page 50 of the *IBM 402 Manual*. Problem number IX-1 might be worked.

5. Total printing from different typebars (Foil 44)

   The total transfer method is used to check the accuracy of each level of total. To print group totals from different typebars using the total transfer method, the exits of the transferring counters must be wired to the entries of the receiving counters. The type of exit to exit wiring used when printing the totals with the same typebars would cause detail or total printing in three places from any one counter. All three counter exits are wired to print entry. The minor counter is controlled from card cycles, and the intermediate and major counters are controlled from the transfer plus or minus hubs. The

carry hubs are wired, and the negative balance hubs are wired in the same way as for printing from the same typebars. The minor, intermediate, and major counter totals are impulsed from the program hubs. The intermediate counter exit must be suppressed on a minor program and the major counter exit must be suppressed on an intermediate program to prevent the intermediate counter from printing minor totals when transferred and the major counter from printing intermediate totals.

6. Explain and diagram figure 45, page 53 of the *IBM 402 Manual*.

7. Counter coupling (Foils 44 and 41)

   Counters of various sizes may be connected to provide for totals of ten and twelve positions. A maximum of sixteen positions may be coupled. The carry exit of the counter containing the units position must be wired to the carry entry of the coupled counter. The CI exit hub of the coupled counter must be wired to the C entry hub of the unit position counter to cause the carryback necessary in subtraction. The negative balance test exit of the high order (coupled) counter only is wired to its negative balance control hub, and the negative balance control hubs of both counters are wired together. The counter control plus or minus hubs and counter total hubs of all coupled counters must be impulsed.

B. Laboratory Problems

1. Minor total transfer—problem XIX-1.
2. Minor and intermediate total transfer, same typebars, counter coupling—problem XIX-2.
3. Total transfer using different typebars—problem XIX-3.

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DIVISION XX: FIELD SELECTION USING CO-SELECTORS

A. Units of Instruction

1. Meaning of field selection (Foil 42)

   Field selection is the printing from either one of two different card fields into one set of typebars by using selectors controlled by the presence or absence of a control punch in a column.

2. Numerical field selection (Foil 44)

   The card field of the cards without an X-control punch is wired from third reading to the normal side of the co-selector, and the field of the X-cards is wired from third reading to the transferred side of the same selector. The common side of the same selector is wired to the print entry hubs. The controlling X-punch is wired from second reading to the X-pickup of a pilot selector, and the coupling exit of that pilot selector is wired to the co-selector pickup hub of the co-selector used. The co-selector will transfer exactly like the pilot selector. (See division XV) In case the field should exceed the number of positions available in a co-selector, two co-selectors may be joined by jackplugging the co-selector pickup hubs to expand the co-selector positions.

3. Alphabetical field selection (Foil 44)

   One co-selector is needed to select zones and one co-selector is needed to select digits. The control punch must be wired from second reading directly to the co-selector pickup of the zone selector. Any digit from 9 through 1 may be used as a control punch, but a 0, 11, or 12 punch would not give the selector time enough to transfer the zones.

   The co-selector used for the digits must be controlled from the coupling exit of a pilot selector. The same digit used to select the zones may be used to select the digits by wiring from the other common hub of the zone co-selector pickup to the D pickup of a pilot selector.

   For mixed alphabetic and numeric field selection using the zone suppress hubs, see page 63 of the *IBM 402 Manual*.

B. Laboratory Problem

Field selection—problem XX-1

DIVISION XXI: CLASS SELECTION USING CO-SELECTORS

A. Units of Instruction

1. Meaning of class selection (Foil 42)
   Class selection is the printing of one card field in either one of two sets of typebars controlled by the presence or absence of a control punch in a column.

2. Numerical class selection (Foil 44)
   The card field is wired from third reading to the common side of a co-selector. Wiring is from the normal side of the same selector to print entry for cards without a control punch and from the transferred side of the selector to another set of print entry hubs for cards with a control punch. The selector is transferred by wiring the controlling card column from second reading to the X-pickup of a pilot selector and by wiring from the coupling exit of the pilot selector to the co-selector pickup.

3. Alphabetic class selection (Foil 44)
   One co-selector is needed to select zones and one co-selector is needed to select digits. The control punch must be wired from second reading directly to the co-selector pickup of the zone selector. Any digit from 9 through 1 may be used as a control punch, but a 0, 11, or 12 punch would not give the selector time enough to transfer the zones.

   The co-selector used for the digits must be controlled from the coupling exit of a pilot selector. The same digit used for zone selection is used for digit selection by wiring from the other common hub of the zone co-selector pickup to the D pickup of the pilot selector.

B. Laboratory Problem

Class selection—problem XXI-1

DIVISION XXII: CROSSFOOTING

A. Units of Instruction

1. Three field crossfootings

   Three fields may be crossfooted from one card or from a group of cards. For instance, the net amount of income may be determined by adding regular earnings plus overtime earnings minus deductions.

2. Hubs not previously introduced (Foil 44)

   a. Non-Print

      Printing and spacing are suppressed when these hubs (Z, 43-44) are impulsed from a total program exit, card cycle, or first card impulse.

   b. Card count

      This hub (L, 44) emits a one-timed impulse as each card passes the third reading station. This hub may be wired to a counter to count cards *or to program start to cause a program start for every card.*

3. Illustration

   See figure 48, page 57 of the *IBM 402 Manual.*

   a. Regular earnings (field A) is added from the card in counter 8A, which totals on a minor program and transfers to counter 8B. Overtime earnings (field B) is added from the card to counter 8B. At minor total time, the regular earnings are received from 8A and added to the overtime amount. At intermediate total time, the combined amount in counter 8B is transferred to counter 8D. The deductions amount (field C) is subtracted in counter 8D from the card. As indicated above, at intermediate total time counter 8D also receives the combined earnings amount from 8B, which is added to the previously subtracted deductions. The final amount in 8D (net income) is printed at major total time.

   b. Detail printing from the counters is prevented by wiring a card cycles impulse to suppress the counter exits of all three counters.

   c. Printing and spacing must be suppressed for the minor and intermediate programs, and this is done by wiring a minor and an intermediate program exit to the non-print hub. (Remember that the non-print hub suppresses both printing and spacing when impulsed.) Only spacing must be suppressed on a major program, so the major program exit is wired to space control hub S (AA, 41).

   d. *All three programs must be taken for each card.* If the card count hub is wired to major program start as indicated in 2B, minor and intermediate program cycles will be forced.

   e. The first card through the machine must be preceded by a blank card. The card count hub emits a "1" impulse only at third reading; therefore, the first card through the machine will not print unless it is preceded by a blank card. The blank card breaks control when it passes third reading and causes totals in the counters to clear. A print cycle is provided for the first punched card.

B. Laboratory Problem

Crossfooting—Problem XXII-1

DIVISION XXIII: SUMMARY PUNCHING

A. Units of Instruction

1. Meaning of summary punching

   A total card containing group identification and a total is automatically prepared from a group of detail cards. Summary punching enables a business to decrease the volume of cards and to increase the speed in preparing reports by using fewer cards. Summary punching combines accumulating on the accounting machine with punching on the reproducer or summary punch. The summary punch cable must be connected to the accounting machine to cause counter exit impulses to be available on the reproducer or summary punch panel. *Only information entered in the counters may be summary punched.*

2. Operation of 402 and 514 for summary punching

   a. Counter impulses (514 panel diagram foil from Part I)

      Impulses caused by the 402 are available on the 514 panel at the sections marked Comparing Magnets or *Counter Total Exit*. Each counter is marked with the same group number as is used on the 402. These impulses are connected to the punch magnets.

   b. Summary punch switch (Foil 44)

      Hubs AA, 49 and 50 must be connected on the 402. These hubs may be connected through a pilot selector picked up by a setup change switch if the same panel is to be used for different operations. The summary punch is used to synchronize the operation of both machines.

   c. Summary punch control (Foil 44)

      Summary punching may take place on any program change. The desired program exit (minor, intermediate, or major) is wired to the pickup hub (X, 49) on the 402. Summary punching will take place just before the total prints. The Transfer and Summary Punch X Control Plus and Minus hubs (S-V, 51-66) on the 402 emit an impulse when the counter is impulsed to total. This impulse when wired to one of the twelve summary punch entry hubs (R-W, 49-50) on the 402 will be available on the 514 at the corresponding column split and may be wired to a punch magnet to punch an X in credit (if wired from S.P.X. Minus) or debit (if wired from S.P.X. Plus) cards.

3. Diagram and explain the wiring for net balance summary punching, figure 73, page 79 of the *IBM 402 Manual*.

4. Summary punching more than one level of total is found on page 85 of the *IBM 402 Manual*.

B. Laboratory Problem

Summary punching—problem XXIII-1

DIVISION XXIV: CARRIAGE CONTROL TAPE

A. Units of Instruction

1. General

   The carriage is controlled by paper tape punched with holes to stop the form on predetermined lines. The carriage will hold a form size up to 22 inches long and 19½ inches wide. These forms are usually continuous forms, but single-sheet forms may be used.

2. Control tape (Show tape)

   The control tape has twelve columnar positions called channels and the tape may be up to 132 lines long depending on the length of the form. The tape must be cut to the length of the form or in multiples of the form length. The punched tape ends are glued together to form a loop, which is placed on a pin-feed device inside the tape control unit. The tape advances in synchronism with the form movement.

   a. Tape channels (Foils 20 and 21)

      These channels or columnar positions perform the following functions:

      First printing line stop is controlled by a punch in channel one. A control panel hub, when impulsed, starts the form skipping and the tape punch stops the form on the correct line corresponding to that punch.

      Channel 2 is used for the first body line stop if heading cards are used; otherwise, it is used as a normal stop. (See page XIV-3 for head control)

      Channels 3 through 11 are used as normal stops. Channels 3 through 8 are standard features; 9 through 11 are optional features.

      Channel 12 is always used for overflow start. All of the other channels stop skipping, but channel 12 is always used to start skipping for page overflow. If this tape punch is *sensed while printing*, the form will advance to the first printing line (channel 1) or body line (channel 2) of the next form depending on additional wiring. The overflow hub on the panel (L, 46) may be wired to nonindicate (L, 45) if no identifying information is needed or to indicate (L, 47) if identifying information is needed. If an invoice is being printed and the number of items to be printed exceeds the number of items that could be printed on one page, a second page must be used. Printing could begin on the first item line of the second page; but if the two pages were to become separated, the second page would be difficult to identify. An identifying number could be printed from counters on the form to relate back to the first page. The customer number could be used. Refer to the *IBM 402 Manual*, page 107, for the wiring of overflow to indicate.

   b. Interlock release

      The feeding of cards is normally stopped while the form is skipping; therefore, causing one card cycle to be lost for each skip. This is called interlocking, and its purpose is to prevent printing *during* the skip for spaces longer than 3⅓ inches (7⅓ for Series 50 machines). When the distance to be skipped is less than 3⅓ inches, the interlock may be released. Obviously, distances frequently skipped should be kept within 3⅓ inches if possible in order to speed up the operation.

3. Operating features

   For a general description of all operating features of the carriage control, consult the *IBM 402 Manual*, page 97.

4. Short form skipping (Foil 44)

   A short form is 3⅓ inches or less in length. Channel 1 is punched to correspond to the first print line on each form. Skipping can be started by a comparing exit or X or digit impulse wired from second read to the Skip to D hub for channel 1 (M, 45). Skipping will stop when a punch in channel 1 is read by the tape reading brushes. If the Interlock Suppress hubs (K, 45-46) are connected, a card cycle will not be lost during skipping.

Skipping also may be started by a first card minor wired to channel 1 skip to I. An example of short form skipping might be name and address labels (problem XIV-1)

5. Single heading forms (Foils 43 and 44)

   a. Head control

      Heading cards are identified by a digit or X punch. The card column containing this significant punch is wired from second reading to Head X or D (digit) Control (I-J, 45-46). This wiring causes the heading cards to print, programming to suspend during heading card printing, eleven card cycles to be inoperative, and an automatic skip between the last card heading and the first line of the body of the form.

   b. First print line (Foil 44)

      It is necessary to start each new form at its proper place which is generally the first line of the heading, which would have been punched in the carriage tape as channel 1. Skipping to this first print line is generally accomplished by wiring a first card impulse to skip to I (for channel 1). When a comparing exit is wired to program start, the first card hub becomes active when the first card of the next group passes third reading. The first card impulse is wired to Skip to I (M, 46) for channel 1. Skipping will start when this impulse occurs and will stop when the channel 1 punch is sensed in the tape.

   c. Overflow (Foil 44)

      Overflow (L, 46) is wired to nonindicate (L, 45) if no identifying information is needed or to indicate (L, 47) if identifying information, such as customer number, is needed at the top of the form.

   d. Interlock release (Foil 44)

      If all distances to be skipped are 3⅔ inches or less, interlock suppress may be wired. If some distances are greater than 3⅔ inches in length, the tape exit may be wired to interlock release for the short distances. The tape exit for channel 1 is wired to interlock release for channel 2 to release the interlock for that skip.

   e. Additional stops (Foil 44)

      Total lines may be predetermined by punching the desired total line of the tape in any normal stop channel. When a total program exit impulse is wired to Skip to I hub of the desired channel, skipping will take place prior to the printing of the total so that the form is at the predetermined line at the time the counters read out. Skipping from the body line to a predetermined total line, which might be indicated in the tape by a 5 punch, (if the skip is less than 3⅔ inches) is accomplished by wiring the tape exit (channel 2) to the interlock release (channel 5).

6. Diagram and explain the wiring necessary to print figure 93, page 103 of the *IBM 402 Manual*.

7. Multiple heading groups—overflow sheet identification. Wiring for skipping to be used in a multiple heading group in itself is not difficult. The same theory is always true for overflow sheet identification. Both of these explanations would need to be illustrated so reference is made to page 107 of the *IBM 402 Manual*. It should be stated at this point that the carriage control for multiple heading groups is probably much easier than the other wiring necessary to print this kind of form. Any problem designed to illustrate skipping for multiple heading groups and for overflow sheet identification should be kept extremely simple until the students become fully aware of all the complications arising from printing forms such as invoices from many different card formats.

B. Laboratory Problem

Short Form Skipping—problem XXIV-1

PART III

ELECTRONIC DATA PROCESSING

The section on computer data processing allows the teacher to choose between COBOL and RPG programming. The teaching sequence will be the same with the exception of Divisions XXX through XXXIII. Divisions XXX and XXXI should be used for COBOL while XXXII and XXXIII should be used for RPG programming. Because of variations in COBOL and RPG, it will be necessary to use the manufacturer's reference manual.

The teaching outline will designate the practice problems in Division XXXVI which should be assigned to give the student practice using the programming principles which have been taught in the classroom. In addition, it will be necessary to be sure that the students understand the accounting principles which the practice problems illustrate.

Practice Problems 1 and 2 are general programs to permit the student to become familiar with the language and the computer. These programs do not require any special accounting principles. The following accounting principles must be understood by the students before starting on Practice Problems 3 through 8.

Problem 3—Sales Journal

1. What is a sale?
2. What is a sales journal?
3. How is the sales journal used in the accounting system?

Problem 4—Purchases Journal

1. What is a purchase?
2. What is a purchases journal?
3. How is a purchases journal used in the accounting system?

Problem 5—Inventory Summary

1. What is an inventory?
2. How is an inventory report used?
3. How are beginning, sales, purchases, and ending quantities and dollar values calculated?

Problem 6—Sales Analysis

1. How is a sales analysis report used?
2. What is the relationship between the sales journal and sales analysis?

Problem 7—Accounts Receivable

1. What is an accounts receivable?
2. How do sales and payments affect the balance of the customer's account?

Problem 8—Payroll

1. How do you calculate regular and overtime pay?
2. How do you calculate FICA, federal withholding, and state withholding taxes?
3. What is a time card?

Teaching Outline for COBOL Programming

I. Introduction to COBOL (4 hours)

For detailed narrative see Divisions XXX and XXXI.

A. Description (XXX-A)

B. Divisions of COBOL (XXX-B)

1. IDENTIFICATION DIVISION
2. ENVIRONMENT DIVISION
3. DATA DIVISION
4. PROCEDURE DIVISION

C. Coding Format (XXX-C)

1. Fields in coding sheet
   a. Line numbers
   b. Continuation
   c. COBOL statement
   d. Identification
2. Coding of COBOL statements
   a. Division names
   b. Section names
   c. Paragraph names
   d. Use of period
3. Reserve words
4. User words

II. COBOL Programming (180 hours)

A. Identification Division (XXXI-A)

1. PROGRAM-ID
2. AUTHOR
3. INSTALLATION
4. DATE-WRITTEN
5. DATE-COMPILED
6. SECURITY
7. REMARKS

B. Environment Division (XXXI-B)

1. CONFIGURATION SECTION
   a. SOURCE-COMPUTER
   b. OBJECT-COMPUTER
2. INPUT-OUTPUT SECTION
   a. SELECT clause
   b. ASSIGN clause

C. Data Division (XXXI-C)

1. FILE SECTION—(FD)
   a. RECORDING MODE IS
      (1) Fixed length records
      (2) Variable length
   b. LABEL RECORDS
      (1) OMITTED
      (2) STANDARD
   c. RECORD CONTAINS
   d. BLOCK CONTAINS
      (1) What is block
      (2) Blocking factor
   e. DATA RECORD IS/ARE
   f. RECORD DESCRIPTION
      (1) Record name
      (2) Level numbers
         (a) Ø1
         (b) Ø2 through 49
      (3) Data names
      (4) Filler
      (5) Elementary items
      (6) Picture clause
         (a) Alphabetic
         (b) Numeric
         (c) Alphanumeric
2. Working-Storage Section
   a. Function
   b. Level numbers
      (1) 77
      (2) Ø1
      (3) Ø2 through 49
      (4) Data names
      (5) Filler
      (6) Picture clause
         (a) Alphabetic
         (b) Numeric
         (c) Alphanumeric
      (7) Value clause

D. Procedure Division (XXXI-D)

1. Relationship to flowchart
2. Paragraph names
3. Statements
4. Function of verbs
5. Input/Output verbs
   a. OPEN
      (1) Input
      (2) Output
      (3) Function
      (4) Relationship to FD
   b. READ
      (1) Function
      (2) Relationship to FD
      (3) AT END clause
   c. WRITE
      (1) Function
      (2) Relationship to FD
      (3) ADVANCING clause
   d. CLOSE
      (1) Function
      (2) Relationship to FD
   e. MOVE
      (1) Function
      (2) Format
      (3) Literal
      (4) Figurative constants
   f. STOP
      (1) Function
      (2) RUN
   g. GO TO
      (1) Function
      (2) Paragraph name

E. Practice Problem 1

1. Review procedures in programming (Division XXXIII).
2. Flowchart and code problem as class project.
3. Have students keypunch, code, compile and test problem.
4. After the completion of the program the student should be able to:
   a. understand the procedure used to write a program, flowchart, code, compile, and test, etc.
   b. understand the purpose of the divisions of COBOL.
   c. code the IDENTIFICATION, ENVIRONMENT, and FILE SECTION of the DATA DIVISION.
   d. use the following verbs: OPEN, READ, WRTE, CLOSE, MOVE, STOP, and GO TO.

F. Add (XXXI-D)

1. Function
2. Format
3. GIVING option

G. If (XXXI-D)

1. Function
2. Format
   a. Condition
      (1) A EQUAL TO B
      (2) A IS LESS THAN B
      (3) A IS GREATER THAN B
      (4) A IS NOT LESS THAN B
      (5) A IS NOT GREATER THAN B
      (6) A IS POSITIVE
      (7) A IS NEGATIVE
      (8) A IS ZERO
   b. Imperative statements
   c. ELSE/OTHERWISE

H. Perform (XXXI-D)

1. Function
2. Format
   a. One paragraph
   b. THRU option
   c. TIMES option
   d. UNTIL option

I. Practice Problem 2

1. Explain the use of a line counter, test the number of lines on the page and explain how to advance to the top of the page.
2. Have students complete Practice Problem 2.
3. After the completion of the problem the student should be able to:
   a. use a line counter to control the printing of headings.
   b. use the following verbs: ADD, IF, and PERFORM.

J. Review verbs and have students complete Practice Problem 3.

K. If time allows students can also complete Practice Problem 4.

L. Subtract (XXXI-D)

1. Function
2. Format
3. GIVING option

M. Multiply (XXXI-D)

1. Function
2. Format
3. GIVING option

N. Divide (XXXI-D)

1. Function
2. Format
3. GIVING option

O. Review COBOL language and LOGIC for Practice Problems 5 through 8.

1. After the completion of these problems the student should be able to:
   a. code simple card input and printer output using a main program and subroutines.
   b. use the following verbs: SUBTRACT, MULTIPLY, and DIVIDE.

Teaching Outline for RPG Programming

I. Introduction to RPG (4 hours)

For detailed narrative see Divisions XXXII

A. Description (XXXII-A)

B. Coding Format (XXXII-A)

1. Page number
2. Line number
3. Form type
4. RPG statement
5. Program identification

C. RPG Specifications (XXXII-C)

1. RPG CONTROL CARD
2. FILE DESCRIPTION
3. FILE EXTENSION
4. LINE COUNTER
5. INPUT
6. CALCULATION
7. OUTPUT-FORMAT

II. RPG Programming (180 hours)

For detailed narrative see Division XXXIII

A. Introduction (XXXIII-A)

B. RPG Control Card (XXXIII-B)

C. File Description Specification (XXXIII-B)

1. Form Type—F
2. Filename
3. File Type
   a. Input—I
   b. Output—O
   c. Update—U
   d. Combined—C
4. File Designation
   a. Primary—P
   b. Secondary—S
5. End of File
   a. Last record indicator—E
   b. No last record indicator—blank
6. Sequence
   a. Ascending—A or blank
   b. Descending—D
7. File Format
   a. Fixed—F
   b. Variable--V
8. Block length
9. Record length
10. Overflow indicator
11. Extension Code
12. Device
13. Symbolic device

D. Extension Specifications Form (XXXII-D)

E. Line Counter Specification Form (XXXIII-E)

1. Form Type—L
2. Filename
3. Line Number and FL or Channel Number

F. Input Specification (XXXIII-F)

1. Form Type—I
2. Filename
3. Sequence
   a. Sequence within control group.
   b. No sequence within control group.
4. Number
   a. Only one record—1
   b. One or more records—N
5. Option
   a. Record required—blank
   b. Record optional—O
6. Record Identification Indicator
7. Record Identification Codes
   a. Position
   b. Not
   c. C/Z/D
      (1) Character—C
      (2) Zone—Z
      (3) Digit—D
8. Field Location
   a. From
   b. To
9. Decimal Positions
   a. Numeric
   b. Alphabetic
10. Field Name
11. Control Level

G. Output-Format Specifications (XXXIII-H)

1. Form Type—O
2. Filename
3. Type
   a. Heading—H
   b. Detail—D
   c. Total—T
4. Space Before
5. Space After
6. Skip Before
7. Skip After
8. Output Indicator
   a. AND relationship
   b. OR relationship
   c. Overflow indicator—OF
   d. First page indicator—1P
   e. Control level indicators
   f. Last record indicators
9. Field name
10. Edit Codes
11. Blank After
12. End Position
13. Constant or Edit Words
    a. Literals
    b. Edit words
       (1) Blank
       (2) Zero
       (3) Ampersand
       (4) Asterisk
       (5) Dollar Sign
       (6) Credit Symbol

H. Practice Problem 1

1. Review procedure in programming DIVISION XXVII.
2. Code problem as a class project.
3. After the completion of the program the students should be able to:
   a. understand the procedure used to code, compile, and a test program.
   b. understand the purpose of the specification sheets for RPG.
   c. code the control card, file description, line counter and output specification sheets.

I. Practice Problem 2

1. Review line counter specifications.
2. Review the uses of constants to set up headings.
3. Have students complete Practice Problem 2.

J. Calculation Specifications (XXXIII-G)

1. Form Type—C
2. Control level
   a. L1 through L9
   b. LR
   c. LO
3. Indicators
   a. On
   b. Not on
4. Factor 1
5. Operation
6. Factor 2
7. Result Field
8. Field Length
9. Decimal Positions
10. Half Adjust
11. Resulting Indicators
12. Operations (These operations should be presented as needed)
    a. ADD (add)
    b. Z—ADD (zero and add)
    c. SUB (subtract)
    d. Z—SUB (zero and subtract)
    e. MULT (multiply)
    f. DIV (divide)
    g. MVR (move remainder)
    h. MOVE (move)
    i. TAG (providing a label for GOTO)
    j. GOTO (branching)
    k. SETON (set indicators on)
    l. SETOF (set indicators off)
    m. COMP (compare)

K. Practice Problems 3 and 4

1. Have students complete Practice Problem 3.
2. If time allows have students complete Practice Problem 4.
3. After the completion of these programs the student should be able to:
   a. code the calculation specification sheet.
   b. code simple card input and printer output.

L. Review RPG language and have students complete Practice Problems 5 through 8.

DIVISION XXV: ELEMENTS OF A COMPUTER SYSTEM (5 hours)

A. General Information (Foil 46)

The four elements which compose any data processing system (input, processing, output, and storage) must also be present in a computer system. The central processing unit (CPU) processes the data. The data are entered into the CPU by some type of input device; it is processed; and then the results of the processing are recorded through some output device. The input service reads data which has been stored externally (i.e., tape, disc, cards, etc.). The data must then be stored internally within the CPU while it is being processed. The processed data will then be stored externally by means of the output device (on tape, disc, cards, printer, etc.).

B. Central Processing Unit

1. Memory (Internal storage)
   Memory in the CPU stores both the data and the instructions by means of electrical impulses. The size of memory determines how much data and how many instructions can be stored in the computer at one time.
2. Arithmetic Unit
   The arithmetic unit performs the mathematical calculations in the program (addition, subtraction, etc.).
3. Logic
   The logic unit tests relationships between data stored in memory. This allows the computer to determine if one amount is greater than another, or if a number is positive, negative or zero. Other tests can be made in addition to the ones described above.
4. Control
   The control unit is the "heart" of the CPU. It determines which instructions are executed and in what order.

C. Input/Output Devices

The computer system can have a number of different possible input devices. No matter what device is used, the basic purpose of the input device is to supply data to the CPU for processing. The output device is just the reverse of the input device. The output device "takes" data from the central processing unit. Often one device can be used as both input and output. When data is coming from the device to the central processing unit, it is input; and when the data comes from the CPU to the device, it is output.

1. Card Reader (Input)
   The card reader is used to read the data punched in cards.
2. Card Punch (Output)
   The card punch is used to punch data into cards. Sometimes the reader and the punch are combined into the same physical unit.
3. Printer (Output)
   The printer is used to provide a "hard copy" report of the data which was processed.
4. Console (Input/Output)
   The console typewriter is used by the computer operator. This is often the means by which the operator communicates with the program and the program communicates with the operator.
5. Magnetic Tape (Input/Output)
   Magnetic tape units are another form of external storage. The unit can be used as input or output. Data are recorded on the tape in the form of magnetic impulses. Normally data must be recorded in a sequence (example: by customer number).
6. Magnetic Disk (Input/Output)
   The magnetic disk, like the magnetic tape unit, also records data by magnetic impulses and can be used for input and output. The disks are similar to records on a modern record player; however, instead of grooves, the disk is covered with a magnetic film similar to the film which is used on magnetic tape. The disk unit has an arm which reads and writes on the disk. Unlike the magnetic tape unit which records data in sequence, the disk unit can be used without data being arranged in a sequence. This procedure is known as a random access.
7. Punched Paper Tape (Input/Output)
   Another form of input and output to the computer which is serial (or must be in

sequence) is the paper tape reader and paper tape punch. Like the card, data are recorded in the paper tape by punched holes. However, the coding pattern is not the same for paper tape as it is for the punched card.

8. Other

In addition to the devices listed above, there are many other devices which can be used as input and/or output to the CPU. Which devices are used will, of course, depend upon the nature of the job and the machine. There is an almost unlimited number and models of devices which can be used. This availability allows for a great deal of flexibility but also means a sound judgment must be made as to what device to select. In addition, these devices can be used as terminals to the CPU. With a large computer, a number of terminals might be connected to the CPU, each in a different location and each sharing the time of the central processing unit.

DIVISION XXVI: CENTRAL PROCESSOR ORGANIZATION (5 hours)

A. Numbering Systems (Foil 47)

Before it is possible to understand how the computer represents data in memory it is necessary to review the concept of a numbering system. Each numbering system has a base. The base determines the number of characters in the system. The highest number in any numbering system is *one less* than the base. For example, the highest number in a decimal system is 9; in an octal system is 8; etc. When the highest number in the system is reached, the series starts over and indicates that it has been through the series by a carry to the next position.

1. Decimal

   The decimal numbering system has a base of ten and, therefore, has ten characters in the system (0, 1, 2, 3, 4, 5, 6, 7, 8, and 9).

2. Binary

   The binary system has a base of two, and has only two characters (0 and 1). The highest character for the binary system is the 1. When the series reaches the highest number, the series starts over with a carry to the next position.

3. Octal

   The octal numbering system has a base of eight, and there are eight characters (0, 1, 2, 3, 4, 5, 6 and 7).

4. Hexadecimal system has a base of sixteen: (0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F). The six characters A through F are used as numbers in the system in addition to the customary digits 0 through 9. It should be noted that when the characters A through F are used in a hexadecimal system, they are used as number and not as letters. They have all of the same characteristics as the numbers 0 through 9.

5. Comparison of numbering systems

Decimal	Binary	Octal	Hexadecimal
0	0	0	0
1	1	1	1
2	10	2	2
3	11	3	3
4	100	4	4
5	101	5	5
6	110	6	6
7	111	7	7
8	1000	10	8
9	1001	11	9
10	1010	12	A
11	1011	13	B
12	1100	14	C
13	1101	15	D
14	1110	16	E
15	1111	17	F
16	10000	20	10
17	10001	21	11
18	10010	22	12
19	10011	23	13
20	10100	24	14

B. Representation of data in memory (Foil 48, 49)

Data is represented in memory in terms of some binary form. The binary form is used because there are only two characters in a binary system and there are only two states in a computer—on or off. Most computers record these binary numbers by means of magnetic core of ferrite rings. The core ring can be magnetized in either a clockwise or a counterclockwise direction. A binary character can then be recorded by having the clockwise direction represent a binary value of 1 and the counterclockwise direction represent a binary value of 0. Each core ring is known as a bit (binary digit).

A group of bits which operate as one unit are known as a byte. The computer generally groups bits by six or by eight in order to record letters and numbers. One method of data representation uses six bits in each byte to represent data plus a parity bit. The parity bit is used by the machine to determine if data within the computer is valid. Each of the six bits are used to represent one character. Each decimal position is coded in binary. This format is known as BCD (Binary Coded Decimal). The six bits are divided into four numeric bits (8, 4, 2, 1), and two zone bits (B,A), which are used with the numeric bit to code alphabetic characters. Octal representation is basically the same as BCD representation (using six bits) except that coding is based on an octal representation ac-

cordingly. The bits are 1, 2, 4, 10, 20, and 40 instead of the BCD bits which are called 1, 2, 4, 8, A, and B.

The hexadecimal system uses eight bits plus the parity to form a "byte" (a unit capable of representing a number, letter, character, etc.). This arrangement allows for the representation of a possible 256 characters instead of the 64 characters for BCD. These extra character possibilities are important in that they allow for more special characters, machine codes, and lower as well as upper case alphabetic characters. With only 65 possibilities under BCD, the computer is considerably more limited in data representation. In addition, hexadecimal permits the "packing" of numeric data. "Packing" is the placing of two numeric characters in one byte. It allows almost twice the number of numeric characters to be represented in the same memory locations than BCD.

DIVISION XXVII: STORED PROGRAM (3 hours)

A. Definition

A program is nothing more than a list of instructions. In order for the computer to do any job it must be instructed step by step. Without a program the computer can do nothing. It is the job of the programmer to write the step-by-step instructions. This program must be stored in the memory of the computer.

B. Types of Programming Languages

1. Machine

   The machine language is the language which the machine can understand. The machine language is not the same for every computer. Each manufacturer has his own machine language, and often the language is different for various types of computers built by the same manufacturer. The machine language is usually numeric. For example, the instruction ADD *may be* represented binarily as 010011 under BCD or 00100011 under hexadecimal.

2. Assembly

   Originally all programming was done in the machine language of the computer. Converting all instructions to a numeric form was a long, tedious job. Soon an assembly language developed, which allowed the programmer to write a program using alphabetic and numeric characters. It allowed the programmer to write a program without having to convert his instructions to the numeric machine language. A program called a language processor, or assembly program, was written by the computer manufacturer to convert the assembly language (source language) to the machine language (object language).

3. Compiler

   With an assembly language the programmer had to write one instruction for each machine instruction. Compiler languages were developed which allowed the programmer to write one statement which would result in a number of machine instructions. In addition, each assembly language was different for each type of computer. With the more sophisticated compiler language, a common programming language was developed, which meant the programmer could change from one type of computer to another without having to learn an entirely different language. The compiler language processor, like the assembly language processor, converted the source language into the machine language (object language).

DIVISION XXVIII: PROCEDURES IN PROGRAMMING (4 hours)

There is a series of steps which the programmer must follow in order to write a program. It is important that the programmer precisely follows each of these steps. The beginning programmer often has the tendency to skip some of those procedures and thus creates problems which are more difficult to solve than they would have been if a careful examination of each step had been completed.

A. Define the Problem (Foil 50)

The first step in writing a program is to define the problem.

1. Input/Output

   The programmer must determine what type of input and output device will be used. It will also be necessary to know the format of the input and output records used. For example if cards are used, the programmer should know where each field is located in the card, what kind of fields they are and what codes are used, if any. If the printer is to be used, the programmer must determine what data is to be printed, and where it will be printed.

2. Scope of the Problem

   The programmer must also determine the general scope of the problem. He must decide what general procedures are necessary to satisfy the needs of the job.

B. Flowcharting (see Division VII)

Once the programmer has defined the problem, he should make a flowchart of the general logic, or steps, that must be taken to do the job. From his general flowchart a detailed flowchart is prepared. This detailed flowchart will show each step in the program and the order in which it occurs in the logical steps of solving the problem.

C. Code Source Program (see Divisions VIII-IX)

From the detailed flowchart the next step is to code the source program. With the help of the flowchart the programmer writes the step-by-step procedures which the computer must follow. Since the actual machine language is not practical to use, some type of symbolic language (assembly or compiler) is normally used.

D. Keypunch Source Deck

The source program, which the programmer has coded, is punched into cards. After the program has been punched in the cards, the programmer should desk-check the cards to be certain that there were no keypunch or coding errors.

E. Assemble or Compile

Since the machine cannot understand the source program, the source program must be converted into the machine language of the computer (object language). This conversion process is known as assembly or compilation. This step is done on the computer by a special program, or series of programs written for this purpose. The assembler or compiler programs are written and supplied in most cases by the manufacturer of the computer.

F. Debug Language Errors

If the programmer has violated any of the rules of the language, the program will not "convert" and the errors must be corrected before the programmer can proceed further.

G. Test

If there are no language errors, the program is tested to determine if the logic, or the order of instructions of the program, is correct. The test should try to include all possible conditions that might occur under the normal use of the program.

H. Debug Logic Errors

After the test has been completed, the programmer must correct the errors in the logic. It is very important that the programmer desk-check his program thoroughly. He should check for other errors in his program in addition to obvious logic errors. Once the errors are corrected, new cards are punched, the program is compiled

again and tested. This process continues until the program is correct in all respects.

I. Documentation

Documentation is an important part of the programming procedure. Once the program is correct, the program should be carefully documented so that others who use the program can follow the logic of the program. The program must be updated to reflect changes in the needs of the user. Without proper documentation, changes to a program can be a major problem. Documentation should include the latest source listing of the program (a computer list of the original instructions), a flowchart of the logic, input and output formats, a description of the techniques used, a sample of the output of the program, and any other materials which may help to define and explain the purpose of the program.

DIVISION XXIX: FLOWCHARTING (10 hours)

A. Definition

A flowchart is a graphic representation of the analysis or solution to a problem. A flowchart is used to plan the logical steps in the solution of a problem. It also is used to document a solution to a problem so that others can better understand the steps taken.

B. Types of Flowcharts (for examples see Division XI)

1. Systems

   A systems flowchart is used to show the flow of data and the operations needed to process the data. The systems flowchart shows where the data originates, what processing is necessary, and in what sequence the steps occur.

2. Program

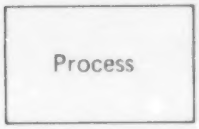
   Program flowcharts are used to describe the sequence of steps in the processing of data in one particular program. The flowchart is used to develop the logic of the program, and to document the finished program.

   The programmer often develops a general flowchart that shows the overall plan for the program. Once the overall general flowchart is completed, detailed flowcharts are developed to support the general flowchart. The program will thus have a mainline routine which is linked to the various sub-routines. This allows the programmer to concentrate on one particular part of the program at a time. It also makes the flowchart easier to follow and easier to correct.

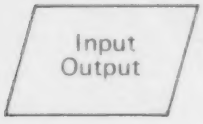
C. Flowcharting Symbols

There are standardized symbols for program flowcharting. The following are suggested as necessary for program flowcharting. The American Standard Flowchart Symbols should be used.

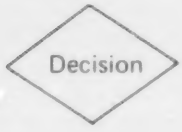
SYMBOLS RELATED TO PROGRAMMING



Any processing function; defined operation(s) causing change in value, form, or location of information.

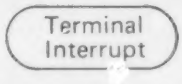


General I/O function; information available for processing (input), or recording of processed information (output).



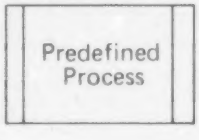
A decision of switching-type operation that determines which of a number of alternative paths followed.

CONNECTOR: Exit to, or entry from, another part of the flowchart.



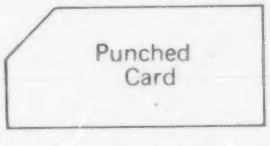
A terminal point in a flowchart—start, stop, halt, delay, or interrupt; may show exit from a closed subroutine.

Instruction modification to change program—set a switch, modify an index register, initialize a routine.

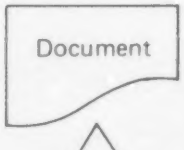


One or more named operations or program steps specified in a subroutine or another set of flowcharts.

SYMBOLS RELATED TO SYSTEMS



Input/Output function in card medium (all varieties).



Printed reports, i.e., invoices, sales journal, etc.

Arrangement of a set of items into sequence.

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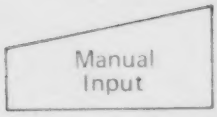
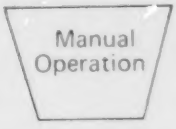
Combining two or more sets of items into one set.

Removal of one or more specific sets of items from a set.

Information display by online indicators, video devices, console, printers, plotters, etc.



Information input by online keyboards, switch settings, push-buttons.



Any offline process (at human speed) without mechanical aid.

AUXILIARY OPERATION: Offline performance on equipment not under direct control of central processing unit.

DIVISION XXX: INTRODUCTION TO A COBOL PROGRAM (3 hours)

A. Description

COBOL (Common Business Oriented Language) is a compiler language that was developed under the auspices of the Department of Defense. The language was developed with the cooperation of a number of manufacturers and users. COBOL was designed to be as close to English as possible and to allow for a language which could be used on more than one machine.

B. Divisions of COBOL

A COBOL program has four divisions: the identification, the environment, the data, and the procedure divisions. One or more COBOL statements make up a paragraph. One or more paragraphs make up a section, and one or more sections make a division.

C. Coding Format

The coding sheet for a COBOL program is divided into four parts: 1) Card columns 1 to 6 are used for line numbering. Each line of coding on the coding sheet is punched into one card. The line number is used to put the cards in sequence. 2) Column 7 is the continuation column. It is used to continue literals that are too long to go on one line of coding (literals will be discussed later in the course). 3) Columns 8 through 72 are used for the COBOL statement. It is here that the programmer writes his instructions, sets up his data, and describes any other information used in the program. Certain COBOL statements must start in column 8; others must start in column 12 or after column 12. For ease of reading and keypunching, lines generally start in columns 8, 12, or 16. 4) Columns 73 through 80 are not used by COBOL. They allow the programmer to put some type of identification in each card of the COBOL source deck. The programmer might punch his program number or anything that he wants to put in those columns, or he could leave them blank.

Division, section, and paragraph names must start in column 8. Other statements must start after column 11. Each COBOL statement must end with a period and a space following the period. The period tells COBOL that this is the end of the statement. Although more than one statement can be put on a card, it is easier to correct the program if each statement is begun on a new card.

There are two kinds of words used in the COBOL language—reserved words and user words. COBOL reserved words are words that have a special meaning to the COBOL compiler. User words are those which the programmer makes up when he writes his program. A space following a word ends the word, so any name which the programmer makes up must not have spaces in the name itself. To avoid this problem, hyphens are used to join the words together that are to be used as a single name. Ex.: Head-line (one word); Head Line (two words).

Some parts of a COBOL program are required; they cannot be omitted. For example, IDENTIFICATION, ENVIRONMENT, DATA and PROCEDURE divisions are required in every COBOL program.

Although COBOL is a common language to machines, it is not possible in this outline to list the different coding for all machines. The programmer must learn to use the reference manual for his own particular type of computer.

DIVISION XXXI: COBOL PROGRAMMING (140 hours)

A. IDENTIFICATION DIVISION

The IDENTIFICATION DIVISION is the first division of a COBOL program. All division names must start in column 8 of the coding sheet. Thus the first card of the COBOL program will be a card with IDENTIFICATION DIVISION punched in the card beginning in card column 8. This card signals the beginning of the IDENTIFICATION DIVISION. The IDENTIFICATION DIVISION serves to give the program a name, show who is the author, tell when it was written, and give other data about the program. The IDENTIFICATION DIVISION card is followed by the PROGRAM-ID statement which must start in column 8. Following the word PROGRAM-ID, the programmer supplies the program with a name. The rules for names which can be used must be governed by the compiler that is being used. IDENTIFICATION DIVISION and PROGRAM-ID are required in every COBOL program. In addition to these required lines, the programmer can include any of the following, all of which must start in column 8 and be terminated by a period.

IDENTIFICATION DIVISION.
PROGRAM-ID. (program space)
AUTHOR. (programmer's name)
INSTALLATION. (entry)
DATE-WRITTEN. (entry)
DATE-COMPILED. (entry)
SECURITY. (entry)
REMARKS. (entry)

B. ENVIRONMENT DIVISION

The ENVIRONMENT DIVISION is the next division in a COBOL program and is a required entry. This division has two main sections, the CONFIGURATION SECTION and the INPUT-OUTPUT SECTION. This division is machine dependent, and the entries that are made will depend upon the computer used and the equipment available. The CONFIGURATION SECTION indicates what is to be the SOURCE-COMPUTER, the computer used to compile the program, and what is to be the OBJECT-COMPUTER, the computer used to run the program.

The INPUT-OUTPUT SECTION indicates which devices will be used in the program. Each input and output file must be given a name selected by means of a SELECT statement, and assigned to a device by use of the ASSIGN clause. The programmer should consult the reference manual for the machine which he is using to determine the proper entries for this division.

C. DATA DIVISION

The DATA DIVISION is the part of the COBOL program where the programmer sets up the fields that are to be stored in memory. Every field that is to be used in the program must be set up in the DATA DIVISION.

There are three sections to the DATA DIVISION. These are: 1) the FILE SECTION, where the data areas for all input and output files are described; 2) the WORKING-STORAGE SECTION, where data files are set up which are not part of the input/output files; and, 3) the CONSTANT SECTION, where constant words are established. This latter section may not always be used, for these words may be set up under the WORKING-STORAGE SECTION. In most programs the CONSTANT SECTION is not used and will not be covered in this description.

1. FILE SECTION

   For each file which has been defined by the SELECT clause in the ENVIRONMENT DIVISION, there must be an FD (file description) in the FILE SECTION of the DATA DIVISION. The FD is begun in column 8 and is followed by the name which the programmer gives to the file in the ENVIRONMENT DIVISION. After this entry, various entries are made to describe the file to the COBOL compiler. The programmer should consult his computer reference manual for the entries which follow since there will be some modifications for each compiler.

   a. RECORDING MODE IS

      The RECORDING MODE IS clause is used to specify if the length of all records

are the same. All cards have the same number of columns and are said to be of fixed length. A file which has the same number of characters in each record is defined as being fixed length. A file in which the number of characters changes from one record to another is said to be variable length record. A tape file might have all records the same length (in which case it would be fixed length) or each record might be a different length (in which case it would be variable length).

b. LABEL RECORDS ARE

The LABEL RECORDS ARE clause is used to specify if label records are OMITTED or are STANDARD on the file. Files such as card files, often do not have label records and the entry would be LABEL RECORDS ARE OMITTED. If label records are to be used on a disk or tape file, the entry would be LABEL RECORDS ARE STANDARD.

c. RECORD CONTAINS (integer) CHARACTERS

This clause is used to indicate the number of characters in the record. For the print file, this clause may read: RECORD CONTAINS 132 CHARACTERS.

d. BLOCK CONTAINS (integer) RECORDS

This clause is used to specify the number of records in a block for tape or disk files. When records are combined together they make up a block. The number of records in a block is known as the blocking factor. Since the computer reads one entire block at a time, this allows the computer to read or write several records at one time. If the blocking factor is 5 for a tape file, the entry would be BLOCK CONTAINS 5 RECORDS.

e. DATA RECORD(S) IS/ARE (record name)

This clause is used to define and name the data records in the file. If there is one data record, the entry would be DATA RECORD IS (record name). If there is more than one record, the entry would be DATA RECORDS ARE (record-name-1, record-name-2 . . .)

f. Record Description

For each record name given in the FD, there must be a record description. Data is described by level numbers and names which are assigned to the level numbers. The record name(s) is/are given the highest level number 01. Fields are described by levels 02 through 49. This allows the record to be divided into fields and subfields into as many as 49 levels. The programmer must give a name to each of the items in the record description. If a part of the record is not used, it is given the name FILLER.

The levels which cannot be further subdivided are known as the elementary items. The elementary item must be described by the PICTURE clause. The PICTURE clause is used to describe the type of data in the item and the size of the item. There can be three types of data: alphabetic, which is specified by the letter A; numeric, which is specified by the number 9; and alphanumeric, which is a combination of letters and numbers and is specified by the letter X. Since alphabetic data can be handled by the X specification the A often is not used.

2. WORKING-STORAGE SECTION

The WORKING-STORAGE SECTION is used to define data fields which are not part of an input or output file. Data is defined in the same manner in which data is defined in the FILE SECTION, except that it is not necessary to include an FD statement since no file is used. In addition to the level numbers 01 through 49, which are used to define field and subfields, the programmer can also set up independent data items by use of the level number 77. The level 77 data fields must come before any 01 level numbers.

The VALUE IS clause can be used to

initialize the fields. For example, if a five position counter with two decimal positions is needed, the entry could be coded PICTURE IS 9(3)V99 VALUE IS ZERO. The VALUE IS ZERO would cause the counter to start off as zeros. If a value of 0.45 was to be initialized in a counter, it could be coded as PICTURE IS V999 VALUE IS .045. If the VALUE clause is not used, the programmer cannot make an assumption as to what will be in the positions when the program first begins.

A five position alphanumeric field could be specified as either PICTURE IS XXXXX, or PICTURE IS X(5). A three position numeric field with no decimals could be specified as PICTURE IS 999 or PICTURE IS 9(3). A six position numeric field with two decimal positions would be specified by PICTURE IS 9(4)V99. The letter V is used to show where the *assumed* decimal point is established in the field.

D. PROCEDURE DIVISION

The PROCEDURE DIVISION is the fourth division in the COBOL program. It is in this division that all instructions are written. The programmer uses his flowchart, which should show the order in which the instructions should be coded. The PROCEDURE DIVISION is divided into paragraphs. Each paragraph is a routine which is made up of a number of statements which perform a specific function. Each statement begins with a verb which describes some action to be taken by the computer when the program is executed. The statement must end with a period and a space. Statements are executed in the order in which they are written unless a branch is used to cause the program to skip to another paragraph in the program. The programmer should consult the reference manual for technical details about the following verbs and their use.

1. Input/Output Verbs

   The verbs which are used to control input and output operations are the OPEN, CLOSE, READ, and WRITE.

   a. OPEN

      Before the program will READ or WRITE a file it must be opened. The OPEN statement must specify if the file is an input or an output file and which file is to be opened. More than one file may be opened by the OPEN statement. The OPEN statement is written as follows: OPEN INPUT (file-name-1, file-name-2 . . .) OUTPUT (file-name-3, file-name-4 . . .).

   b. READ

      After an input file has been opened it can be read. The READ statement is written as follows: READ (file-name) AT END (statement). Each time the READ statement is executed the next record is placed in the area defined in the FD of the DATA DIVISION. The AT END clause must be written for each READ statement. Any statement may follow the AT END clause. The GO TO statement is often used to force the program to branch to another part of the program when the end of the file is reached. The GO TO statement will be discussed later in this section.

   c. WRITE

      The WRITE statement is used for an output file. Once the file has been opened it can be written by the WRITE statement, which is coded WRITE (record-name). For a print file the ADVANCING option can be used to cause the printer to space before or after the printing operation. The statement is coded as follows: WRITE (record-name) (BEFORE/AFTER) ADVANCING (integer) LINES.

   d. CLOSE

      Once the programmer has finished with the file, the file should be closed with the CLOSE statement. It is written as follows: CLOSE (file-name-1, file-name-2, . . .).

2. MOVE

   The MOVE statement is used to transfer data from one part of memory to another part of memory. The statement is written as follows: MOVE (data-name-1 / literal /

figurative-constant) TO (data-name-2). The data in the first part of the MOVE statement is copied in the positions in data-name-2. If a data name is used it must be set up in the DATA DIVISION. A literal is a value which has not been set up in the DATA DIVISION and cannot be referenced by a data name. A figurative constant is a value which is often used as a literal and has been given a special name. Two figurative constants which are often used in a COBOL program are SPACE or SPACES and ZERO or ZEROS.

3. STOP

The STOP statement is used to cause the execution of the program to halt. The STOP statement is written STOP RUN or STOP (literal). STOP RUN causes the program to halt and the program cannot be restarted. The STOP (literal) causes the program to STOP but by pushing the run button the program will execute the next instruction after the STOP statement. The literal can be used to determine where the program stopped.

4. GO TO

Instructions are normally executed in the order in which they are written. The GO TO statement is used to cause the program to branch to another part of the program. The GO TO statement is written as follows: GO TO (paragraph name). The next instruction to be executed will be the first statement of the paragraph specified.

5. Arithmetic Verbs

For each of the following arithmetic verbs, COBOL aligns the data field according to their assumed decimal point.

a. ADD

The ADD statement is coded as follows: ADD (data-name-1 / literal; data-name-2 / literal . . .) TO (data-name-n). When this statement is executed, the data in the first data-name(s) are added algebraically to the last data-name. The first data-name(s) are not changed. The ADD statement can also be written as follows: ADD (data-name-1 / literal; data-name-2 / literal / . . .) GIVING (data-name-n). In this case, the data-name and/or literals are added together and the result is stored in data-name-3. Data-name-3 is not part of the addition and thus the original data in the data-name will be replaced with the result of the addition.

b. SUBTRACT

The SUBTRACT statement can be written as follows: SUBTRACT (data-name-1 / literal; data-name-2 / literal . . .) FROM (data-name-n). In this case, each of the data-name(s)/literal(s) are subtracted algebraically from the last data-name. The result is stored in the last data-name. The first data-names do not change.

The SUBTRACT statement can also be written SUBTRACT (data-name-1/literal; data-name-2/literal . . .) FROM (data-name-n-1) GIVING (data-name-n). The result in this case replaces the data which was stored in data-name-n. The data in all other data-names remains unchanged.

c. MULTIPLY

The MULTIPLY statement has two formats: MULTIPLY (data-name-1 / literal-1) BY (data-name-2); or MULTIPLY (data-name-1 / literal-1) BY (data-name-2 / literal-2) GIVING (data-name-3). The only difference between the two statements is that in the first case the result is stored in data-name-2 and in the second case data-name-2 is not destroyed and the result is placed in data-name-3.

d. DIVIDE

The DIVIDE statement like the MULTIPLY has two formats: DIVIDE (data-name-1 / literal-1) INTO (data-name-2); or DIVIDE (data-name-1 / literal-1) INTO (data-name-2 / literal-2) GIVING (data-name-3). In the first statement the result is stored in data-name-2 and in the second the result is stored in data-name-3 without changing data-name-2.

6. IF

The IF statement is used to test relationships between data fields. The basic format for simple conditional statements is IF (condition) (imperative statement(s)) ELSE/OTHERWISE (imperative statement(s)). The condition could be written as follows: (1) A IS EQUAL TO B, (2) A IS LESS THAN B, (3) A IS GREATER THAN B, (4) A IS NOT EQUAL TO B, (5) A IS NOT LESS THAN B, (6) A IS NOT GREATER THAN B, (7) A IS POSITIVE, (8) A IS NEGATIVE, or (9) A IS ZERO. The imperative statement is any direct COBOL command such as MOVE, ADD or OPEN.

The second half of the statement, ELSE/OTHERWISE (Imperative statement(s)), is not required. ELSE and OTHERWISE can be used interchangeably without changing the meaning of the statement. If used, ELSE and OTHERWISE allow the programmer to instruct the computer to execute another statement(s) if the condition is *not* true.

7. PERFORM

The PERFORM, like the GO TO, is used to alter the sequence in which the instructions are executed. The PERFORM allows the programmer to branch out of the main routine and execute one or more paragraphs and then automatically returns to the next statement following the PERFORM statement. To execute only one paragraph, the statement is written as follows: PERFORM (paragraph-name). To execute several consecutive paragraphs the PERFORM is written PERFORM (paragraph-name-1) THRU (paragraph-name-n).

The TIMES clause allows a paragraph to be performed several times. It is written as follows: PERFORM (paragraph-name-1) (integer / data-name) TIMES.

The UNTIL clause causes the paragraph to be performed until some condition is met. It is written as follows: PERFORM (paragraph-name) UNTIL (condition).

DIVISION XXXII: INTRODUCTION TO RPG (3 hours)

A. Description

IBM began development of RPG, a specialized programming language, in the 1950's. RPG (Report Program Generator) is a higher-level language that has been altered and improved and has become a major language for The Model 20 of the IBM System/360. RPG was further modified into RPG II, which was introduced in the 1970's to be used with the IBM System/3. RPG was designed specifically for the creation of business reports.

B. Coding Format

There are seven different coding specifications for RPG, some of which may be combined onto one coding sheet. Each coding specification is used for a specific purpose in an RPG program. Although most of the fields on the coding sheets are different, there are certain fields which are common to all of the coding sheets.

The page number for each sheet is coded in card columns 1 and 2. In addition each line on the coding sheet can be assigned a number by using card columns 3 through 5. Together the page and line numbers can be used to give each line of coding a different number so the cards can be easily arranged in sequence.

Each card in the source program must specify the form type in card column 6. The form type identifies one of the seven specifications used in RPG.

Card columns 7 through 74 are used to code each RPG statement. The programmer may code an * in card column 7, specifying that line of coding will not be treated as a source statement in the program. This specification allows the programmer to be able to insert comments to document his work into the program. The line of coding will be printed on the source listing but will not generate any object coding by the compiler.

Card columns 75 through 80 are used for program identification. The program number or name can be punched in these columns.

C. RPG Coding Specifications

RPG uses seven different specification forms in the coding of an RPG source program. The seven specification forms are:

1. RPG CONTROL CARD specification which is used to guide the computer in the compilation of the RPG program.
2. FILE DESCRIPTION specification is used to indicate the input and output equipment needed by the program.
3. FILE EXTENSION specification is used to give information about tables to be used by the program.
4. LINE COUNTER specification is used to control printed output when it is to be printed at a later time or by a printer that does not have a carriage control tape.
5. INPUT specification is used to describe the format of the input records.
6. CALCULATION specification is used to describe mathematical calculations, decisions and data movements in the program.
7. OUTPUT-FORMAT specification is used to describe the format of the output records.

DIVISION XXXIII: RPG PROGRAMMING (140 hours)

A. Introduction

An RPG program is written by supplying the compiler with information about the nature of the program. To a large extent the logic of the program is determined by the compiler. The programmer describes the input, what processing is necessary, and what should be included in the output. The compiler will determine what steps it must take to produce the desired output.

This division will describe the basic fields which are used in the specification forms. Additional information about RPG can be found in the programmers' reference manual. The examples in these sections will be limited to card input and printed output.

B. RPG Control Card

The RPG control card is used by the RPG compiler for certain special conditions. For most simple jobs it is only necessary to punch the letter H in card column 6, to indicate that this is a header card.

C. File Description Specifications

The file description specification is used to describe the input and output equipment needed by the program. These cards link the files described on the input and output specifications to the physical input and output devices. There must be one line of coding for each input and output file used in the program.

1. Form Type (card column 6)
   The letter F is punched in *each* file description card to identify it as a file description card.
2. Filename (card columns 7-14)
   The programmer must give each file a name of not more than 8 characters. The name should start in column 7 and begin with an alphabetic character. There must be no embedded blanks and the name should be made up of letters and numbers.
3. File Type (card column 15)
   One of the following entries should be made in column 15:
   I—identifies an input file
   O—identifies an output file
   U—identifies an update file, which would be used by a direct access medium (disk file) when the file is used for both input and output
   C—identifies a combined file for cards which are going to be read and also punched
4. File Designation (card column 16)
   In the case of a card input file 'P' should be entered here to designate that it is the primary file. This column is blank for the printer file.
   P—primary file
   S—secondary file
   R—direct access storage for handling record address files
   C—chained file
   T—table file
5. End of File (card column 17)
   The letter E is used in this field to cause the LR (last record) indicator to turn on when the last record of an input file has been read. For output files this field is blank.
6. Sequence (card column 18)
   The letter A is used to specify that the input file is in ascending order and the letter D is used to specify descending order. If the column is left blank, RPG assumes ascending order.
7. File Format (card column 19)
   The letter F is used to specify that the file will have fixed length records and the letter V is used to denote variable length records.
8. Block Length (card columns 20-23)
   This field is used to specify the length of the block. Since the standard card is 80 columns and is unblocked, the entry for a card file would be 80.
9. Record Length (card columns 24-27)
   This field specifies the length of the record. Since the card is 80 columns, the entry would be 80.
10. Overflow Indicator (card columns 33-34)
    The entry of OF can be used to specify a skip from the bottom of the printer output

page to the top of the next page. The OF indicator will be turned 'ON' each time the page overflows. This indicator can be used on the output specification form to control the printing of headings.

11. Extension Code (card column 39)

    The entry of L in this field is made if more information is necessary on the line specification sheet.

12. Device (card columns 40-46)

    This field is used to specify the type of input or output device.

    PRINTER—printer
    READ01—IBM 2501 card reader
    READ20—IBM 2520 card read-punch
    READ40—IBM 2540 card read-punch
    READ42—IBM 1442 card read-punch
    TAPE—magnetic tape output unit
    DISK11—IBM 2311 disk storage drive

13. Symbolic Device (card columns 47-52)

    This field will not be used in these examples.

D. Extension Specification Form

The Extension Specification Form is used to provide information about chaining files, tables and record address files. These specifications will not be discussed in this outline.

E. Line Counter Specification Form

The Line Counter Specification Form is used when printed output is stored on an intermediate device such as tape or disk to be printed later. The system which is being used will determine if this specification is required.

1. Form Type (card column 6)

   Each Line Counter Specification must have an L punched in this field.

2. Filename (card columns 7-14)

   The printer filename which was used on the File Description must be entered in this field.

3. Line Number and FL or Channel Number (card columns 15-19)

   For each channel to be used, the programmer must specify the line number and the channel to which that line number will apply. The programmer would then normally use the first two specifications to indicate the line number for channel 01 (top of page) and the line number for channel 12 (end of page).

F. Input Specifications

The Input Specifications sheet is divided into two parts: record identification (card columns 7-42) and field description (card columns 43-74). The record identification positions are used to specify record identification codes and the relationship to other records in the file. The field description is used to describe the fields of the input record. The record identification data and the field description should not be coded on the same line.

1. Form Type (card column 6)

   The letter I must be punched in each card to identify the card as an input specification sheet.

2. Filename (card columns 7-14)

   Each input file must have a filename. This must be the same name which the programmer specified in the filename field on the file description sheet.

3. Sequence (card columns 15-16)

   The sequence field is used to check the sequence of cards within a control group. An example of a control group is the customer number. If the first card is the balance card; the second, the payment card; and the last, the sales card; then this sequence must be specified in the RPG program. This is done by assigning numbers in the sequence field. The entries must begin with 01 and be assigned consecutively for each record. If the file is not in sequence the halt indicator HO is set on. The HO indicator must be set off by the SETOF operation or the program will terminate. (See Calculation Specifications).

   If the input records do not have to be in sequence within the control group, alphabetic codes must be placed in the sequence field.

4. Number (card column 17)

   If an alphabetic code was used in the sequence field, this field must be blank.

   If 1 is specified in the number field, only

one record of this type may exist within a control group. If N is specified, one or more records of this type may exist within a control group.

5. Option (card column 18)

   If an alphabetic code was used in the sequence field, or if the record is required, this field must be blank. If the record being specified is optional, the letter O is entered.

6. Record Identification Indicator (card columns 19-20)

   This specification is used to establish a two-digit code which is used by the object program to determine which input is read into the system. The programmer can use these codes to refer to the record on the calculation and output specifications. The indicator will be set 'ON' or 'OFF' as a result of a test of the record identification code(s).

7. Record Identification Codes (card columns 21-41)

   These specifications are used to identify the codes which are used in the input record. If these conditions are present the Record Identification Indicator is set 'ON.' As many as 3 codes can be set up on one line of the RPG Input Specification Sheet. Additional entries can be coded by using more than one card and coding the word AND starting in column 14. In this case all entries must be true for the indicator to be set 'ON.' The OR relationship can be specified for two different record types with one set of record descriptions by coding OR starting in column 14.

   The Record Identification Codes are divided into three sets. Each set is divided into four categories: position, not, C/Z/D and character.

   a. Position

      The position field specifies the position of the character in the input record that contains the identifying code. The entry must be numeric and right justified.

   b. Not

      An entry of N specifies that the code must not be present for the indicator to be set 'ON.' If the entry is blank the code must be present to be set 'ON.'

   c. C/Z/D

      An entry of C specifies the entire character will be tested. An entry of Z will test the zone only and an entry of D will test the digit only.

   d. Character

      This entry specifies the character which will be compared with the character specified in the input record.

8. Field Location (card columns 44-51)

   The field location positions are used to specify the location of each field in the input record. The entries must be numeric and right justified.

   a. From (card columns 44-47)

      This specification is used to code the leftmost position of the field.

   b. To (card columns 48-51)

      This specification is used to code the rightmost position of the field.

9. Decimal Positions (card column 52)

   This entry specifies the number of decimal positions in a numeric field. If the field is alphabetic the specification must be left blank. There must be an entry to edit or zero suppress a numeric field.

10. Field Name (card columns 53-58)

    Each field which is defined must be given a name. The field name must begin with an alphabetic character and start in position 53. The field name may be alphanumeric and cannot contain embedded blanks.

11. Control Level (card columns 59-60)

    This specification is used to designate the control fields in the input data. Up to nine control levels can be used. These are designated from low to high as L1, L2, L3 . . . L9. An indicator is set for each control level.

G. Calculation Specifications Form

The Calculation Specifications are used to determine the operations to be performed by the object program. Each operation is specified on

one line of the form. Operations must be listed in the order in which they are to be performed with all detail calculations preceding total calculations.

The Calculation specification is divided into three parts. Card columns 7 to 17 determine when the calculations are performed. The type of calculations to be performed are specified in columns 18 to 53. Card columns 54 to 59 are used to test the results of calculations.

1. Form Type (card column 6)

   The letter C must be punched in each card to identify the card as a Calculation Specification.

2. Control Level (card columns 7-8)

   An entry in these positions indicates that the calculation is to be performed at total time. If these positions are left blank the calculation will be performed at detail time.

   The entries L1 through L9 may be specified in these positions. These are the same as the control levels that were specified in the Input Specifications to determine when control breaks would occur. In addition LR can be used for the last record indicator. The LO indicator is on throughout execution of the object program and is used to specify total calculations when no control break has occurred. The LO can be used to accumulate totals for each page.

3. Indicators (card columns 9-17)

   From one to three indicators can be specified for both total and detail calculations to control when the calculations will be executed. The record identification indicators which were described in the Input Specifications can be used in these positions. The indicators are entered in card columns 10-11, 13-14, and 16-17. The letter N can be entered in card columns 9, 12 and/or 15 if it is necessary to indicate that the indicator must not be 'ON' for the calculation to be performed.

4. Factor 1 (card columns 18-27)

   This specification can be a field name, a literal or a label. If a field name is used it must have been defined on the Input Specifications form or in the result field of the Calculations Specifications. Field names must be left justified.

5. Operation (card columns 28-32)

   These entries specify the operation that is to be performed using factor 1, factor 2 and result field.

6. Factor 2 (card columns 33-42)

   The description of factor 2 is the same as factor 1.

7. Result Field (card columns 43-48)

   This specification is used to set up storage that is to contain the result of the calculation. The name must be alphanumeric and left justified.

8. Field Length (card columns 49-51)

   This entry specifies the length of the result field. When the field is used more than once, the length of the field must be the same in all calculations.

9. Decimal Positions (card column 52)

   This entry indicates the number of decimal positions in the result field. If the result field does not have any decimal positions, the entry must be 0.

   If the result field is alphanumeric, this position must be blank.

10. Half Adjust (card column 53)

    An entry of H will cause the result field to be rounded to the nearest whole number.

11. Resulting Indicators (card columns 54-59)

    The resulting indicators can be set ON or OFF as the result of the COMP, SETON, or SETOF instructions. The indicators can also be set ON or OFF as the result of arithmetic operations to indicate if the result was plus, minus, or zero.

12. Operations

    The following is a brief description of the operations that can be used on the Calculation Specifications sheet.

    a. ADD (add)

       The data in factor 2 is added to factor 1 and the result is placed in the result field.

b. Z-ADD (Zero and Add)

The result field is set to zeros and factor 2 is placed in the result field. Factor 1 is not used.

c. SUB (Subtract)

The data in factor 2 is subtracted from factor 1 and the result is placed in the result field.

d. Z-SUB (Zero and Subtract)

The result field is set to zeros and factor 2 is made negative and placed in the result field. Factor 1 is not used.

e. MULT (Multiply)

The data in Factor 1 is multiplied by the data in factor 2 and the product is placed in the result field.

f. DIV (Divide)

The data in factor 1 is divided by the data in factor 2 and the quotient is stored in the result field. Any remainder is lost unless the move remainder operation (MVR) is specified as the next operation.

g. MVR (Move Remainder)

The remainder from the divide operation is moved to the result field. Factor 1 and factor 2 are not used.

h. MOVE (Move)

Data in factor 2, beginning with the rightmost position, is moved to the rightmost position of the result field. If factor 2 is longer than the result field, the left most positions of factor 2 are not moved. If the result field is longer than factor 2 the positions to the left of the data being moved are left undisturbed.

i. TAG (Providing a label for GO TO)

This entry allows the programmer to provide a name to which the program can branch. The label is entered in factor 1. Factor 2 and the result field are not used.

j. GOTO (Branching)

This entry causes the program to branch to another part of the program. Factor 2 specifies the label to which the program will branch. Factor 1 and the result field are not used.

k. SETON (Set Indicators On)

This entry causes the indicators specified in positions 54-55, 56-57 or 58-59 to be set ON. Factor 1, factor 2 and result field are not used.

l. SETOF (Set Indicators Off)

This causes the indicators specified in positions 54-55, 56-57 or 58-59 to be set OFF. Factor 1, factor 2 and result field are not used.

m. COMP (Compare)

This entry is used to compare the field or literal in factor 1 against factor 2. The result of the compare will set the resulting indicators in positions 54-59. The high indicator is set when factor 1 is greater than factor 2. If factor 1 is less than factor 2, the low indicator is set. If the two fields are equal, the equal indicator is set.

H. Output-Format Specifications

The Output-Format Specifications specifies the type of output files to be produced and the location of the data fields. The specifications are divided into two parts: File Identification (positions 7-31) and Field Description (positions 23-74). The File Identification data cannot be coded on the same line as the field description data.

1. Form Type (card column 6)

   The letter O must be punched in each card to identify the card as an Output-Format Specification.

2. Filename (card columns 7-14)

   Each output file must have a filename. This must be the same as the name which the programmer specified in the filename field on the File Description Specification sheet.

3. Type H/D/T (card column 15)

   This specification indicates the type of record to be described. The following entries are used:

a. H—Heading record
b. D—Detail record
c. T—Total record

Heading records must be described first followed by detail records and then by total records.

4. Space Before (card column 17)

This specification is used to control spacing before the line is printed. The entry in this position must be 0, 1, 2, 3 or blank. If the position is blank no spacing is provided before printing.

5. Space After (card column 18)

This specification is used to control spacing after the line is printed. The entry in this position must be 0, 1, 2, 3 or blank. If the position is blank no spacing is provided after printing.

6. Skip Before (card columns 19-20)

An entry of 01 through 12 will cause the printer to skip to that channel before the line is printed. If this entry is blank, no skipping is provided before printing.

7. Skip After (card columns 21-22)

An entry of 01 through 12 will cause the printer to skip to that channel after the line is printed. Should this entry be blank, no skipping is provided after printing.

8. Output Indicator (card columns 23-31)

The output indicator specifications are used for both the file identification section (positions 7-31) and the field description section (positions 23-74). When two or more indicators are specified, they are considered to be in an AND relationship. Up to 3 indicators can be specified on one line. Additional indicators can be specified by coding AND in positions 14-16. An OR relationship can be specified by coding OR in positions 14-15. An OR specification cannot be used to condition a field but can be used for a file. The description for each indicator allows the indicator to be tested to determine if it is 'ON' or 'OFF.' By coding an 'N' in the Not position the programmer specifies that the indicator must not be 'ON.'

The overflow indicator (OF) and the first page (1P) indicator can be used for heading lines. The OF indicator is used whenever the printer spaces to the top of the page. The 1P indicator is set for the first page only. The detail line can also use the indicators which the programmer set up by the Input Specifications. The total lines can use the control level indicators (L1-L9) and the last record indicator (LR) which is set when the last input record is read.

9. Field Name (card columns 32-37)

This field is used to specify each field to be written. The fields will be moved in the order in which they are written.

RPG will automatically number the pages of printer output when the programmer specifies the word PAGE in the field name.

10. Edit Codes (card column 38)

An entry of Z will cause zero suppression of a numeric field. When an edit word is used, the edit code field must be blank.

11. Blank After (card column 39)

An entry of B will cause the field to be reset to blanks for an alphanumeric field or reset to zeros for a numeric field after placing the field in the output record.

12. End Position in Output Record (card columns 40-43)

This specification is used to indicate the low-order position to which the field will be moved in the output record.

13. Constant or Edit Word (card columns 45-70)

The programmer can set up literals that are to be printed on the output report by coding an apostrophe, followed by the characters of the literal, and a closing apostrophe. This method is used to set up headings for the printed output. The field name must be blank for any line coded with a constant.

Edit words allow the programmer to insert dollar signs, commas and periods in numeric fields. An edit word must be coded with a beginning and closing apostrophe. A blank space in the edit word is replaced with a numeric character from the data field. The

ampersand is used to cause the edit word to leave a blank space in the data which is being edited. A zero is used to suppress leading zeros. A zero can be placed in the rightmost position where zero suppression is to take place. An asterisk can be used to cause asterisk protection and zero suppression. The asterisk should be placed in the rightmost position of where zero suppression is to take place. An asterisk will replace each position which is left blank by the zero suppression. If a dollar sign is written to the left of the zero the dollar sign will be inserted to the left of the first significant digit. The dollar sign will "float" to the right and be positioned in front of the first significant digit. A dollar sign that is written immediately to the right of the apostrophe will not float but will remain fixed in the position as written. Decimal point and commas are printed in the edited output in the same positions as written unless zero suppression is specified; then if they are preceded by zeros, the decimal and commas are blanked out. The CR (credit symbol) or minus will be left undisturbed if the field is minus. If the field is positive, the CR or minus will be blanked out.

DIVISION XXXIV: THE DATA PROCESSING DEPARTMENT (30 hours)

A. Functions

The data processing department should provide a service to the business organization. It should provide management with the reports they need to make sound decisions. In order to do this the department must gather, process, and distribute data to management.

B. Selection of Equipment

The selection of equipment is divided into two major parts: (1) getting proposals from manufacturers and (2) evaluating of the proposals. It is important for the organization to define clearly the objectives and requirements of the needed data processing system. Without a clear idea of what is needed, the organization is forced to accept the manufacturers' judgment of what should be included in the system. Some factors which should be considered are: hardware performance, software performance, cost, manufacturers' support, compatibility, growth, delivery, and availability of application programs.

C. Personnel

1. Supervisors

   The supervisor is the person who has the responsibility for the data processing department. In a small organization, there might only be one supervisor, but in a large organization, there might be a supervisor for such areas as systems, programming, and operations.

2. Systems Analyst

   The systems analyst is responsible for the design and improvement of the data processing system. He outlines the system and provides guides for the programmer.

3. Programmer

   The programmer is responsible for the flowcharting, coding, debugging, and documentation of the programs necessary to implement the system.

4. Computer Operator

   The operator runs the programs on the computer. He must follow the detailed procedure for each program, which has been supplied by the programmer.

5. Keypunch Operator

   The keypunch operator punches data into cards. In some organizations, the data is keyed on to tape instead of cards.

6. Unit Record Equipment Operator

   The unit record operator is responsible for the punched card equipment such as the sorter, collator, and accounting machine.

PART IV
TEACHING AIDS

DIVISION XXXV: UNIT RECORD LABORATORY PROBLEMS

V-1 Keypunch

Using the following fields, punch a card using your own name and address etc. Check the card to make sure there are no errors.

Field	Card Columns
Social Security	1-9
First Initial	10
Second Initial	11
Last Name	12-22
Street Address	23-33
City and State	34-44
Zipcode	45-49

V-2 Program Card

Using the following fields, set up and punch a program card.

Field	Card Columns
Customer Name	1-20
Invoice Number	21-25
Invoice Date, Month, Day	26-29
Customer Number	39-43
Quantity	44-47
Item Number	50-52

V-3 Keypunch and Program Card

Using the program card punched in problem number 2, punch the following data into the proper field. Make sure there are no errors.

Field	Data
(A) Customer Name	Jones Co.
Inv. No.	304
Inv. Date	Sept. 29
Customer No.	50784
Qty.	25
Item No.	107
(B) Customer Name	Allen and Stern
Inv. No.	1045
Inv. Date	Oct. 13
Cust. No.	14976
Qty.	351
Item No.	074
(C) Customer Name	Brown Co.
Inv. No.	17045
Inv. Date	July 4
Cust. No.	57892
Qty.	3
Item No.	784
(D) Customer Name	A. B. C. Co.
Inv. No.	17420
Inv. Date	Nov. 14
Cust. No.	143
Qty.	45
Item No.	342

VI-1 Sequencing

Sequence the sales analysis deck (=774891) by the invoice number (card columns 21-25)

VI-2 Selection

Select all cards for salesman =3 from the sales analysis deck (card column 33).

VI-3 Grouping

Group the cards according to salesman number (card column 33).

VI-4 Sequence by more than one field

Sequence the sales analysis cards by product item number within product group number. (Item number 50-52, group number 48-49).

VI-5 Sequence by more than one field

Sequence the cards by item number within branch. (Item number 50-52, branch 30-31).

Note: In order to use the following problems, it will be necessary to straight reproduce (80-80) several decks of the original problem deck.

VIII-1 Read to print

Wire a control panel using the following fields and interpret the above 12-rows.

Field	Card Columns	Typebars
Product Description	1-20	1-20
Invoice Number	21-25	56-60
Invoice Date		
Month	26-27	49-50
Day	28-29	52-53

VIII-2 X-elimination

Using the cards from the previous problem, wire a control panel and print between the 12 and 11 row. Eliminate the X-punch in column 58.

Field	Card Columns	Typebars
Group	48-49	11-12
Item	50-52	3-5
Customer Number	39-43	56-60
Sales Amount	53-58	45-50

VIII-3 Class Selection

Interpret the cards using the following data. Select the printing of the cost amount on an X58 condition.

Field	Card Columns	Typebars
		X 55-60
Cost Amount	59-64	NX 45-50
Invoice No.	21-25	1-5

VIII-4 Field Selection

Using the X78 condition, select the fields to be interpreted as shown below. Eliminate the X-punch in 58.

Field	Card Columns	Typebars
Sales	53-58	45-50 X cards
Cost	59-64	45-50 NX cards
Invoice No.	21-25	1-5

IX-1 Gang Punching

a. Keypunch a master card and gang punch into 15 blank cards the following data.

Field	Data	Card Columns
Description	Flour	1-15
Product No.	3491	16-19
Unit Price	12.34 (001234)	20-25
Vendor No.	379-87 (37987)	70-74

b. Keypunch a master card and gang punch into 10 blank cards the following data. Using the same card columns as above.

Field	Data
Product Description	Pickles
Product No.	4701
Unit Price	7.04 (000704)
Vendor No.	381-22 (38122)

IX-2 Straight Reproducing

a. Using the following fields in the sales analysis deck (IBM No. 774891), reproduce the data into a new deck of cards using the same card columns.

Field	Card Columns
Product Description	1-20
Product Number	21-25
Group	48-49
Item	50-52
Branch	30-31

b. Repeat the above experiment and move the data to the following fields.

Field	Card Columns
Product Description	6-25
Product Number	26-30
Group	1-2
Item	3-5
Branch	64-65

IX-3 Interspersed Gang Punching

a. Using the two master cards in problem 1 above, intersperse gang punch the data and compare. Use five detail cards behind each master. The detail cards should only have an X-punch in column 76.

b. Repeat the same problem as above only add an X punch in column 79 of the master cards. The detail cards should have no X-punch.

X-1 Merging

Sequence the cards by Invoice number (card columns 21-25). Select from the file all cards which have a 2 punched in card column 48. Wire the collator control panel to merge the two groups of cards and check sequence.

X-2 Matching

Keypunch one card for each of the following using card columns 21 to 25 (Invoice Number).

00006	00012
00007	00013
00010	00014
00011	00022

Wire the collator control panel to match the key punched cards and the sales analysis deck using card columns 21 to 25.

X-3 Merging with selection

Using the cards key punched in problem 2, wire the collator to merge with selection using the same card columns (21-25).

402 PRACTICE PROBLEMS

The IBM Functional Wiring Principles Practice Problem deck (=774891) is used for the problems in Divisions XII through XXI. Refer to foil 45 for the card columns to be used in the laboratory problems. Prepare a control panel diagram and wire a 402 control panel for all problems.

Problem XII-1

1. Detail print.
2. Use the alphamerical typebars only for this problem.
3. Form Layout:

Invoice Number	*Salesman*	*Customer Number*

Problem XII-2

1. Detail print.
2. Select print positions so that the report will be evenly spaced.
3. Suppress insignificant zeros.
4. Form Layout:

Product Description	*Cost Amount*	*Sales Amount*	*Product Number*

Problem XII-2A

1. Change problem XII-2 so the sales amount also prints in two positions on the report.
2. Detail print.

Problem XIII-1

1. Use the same report headings given in problem XII-2.
2. Add the cost amount and the sales amount in counters.
3. Print a final total.
4. Detail print.

Problem XIV-1

1. Take a minor total of sales amount by invoice number. Print an asterisk after totals.
2. Sort cards in ascending order by invoice number.
3. Detail print.
4. Form Layout:

Invoice Number	*Product Description*	*Sales Amount*

Problem XIV-2

1. Take a minor total of sales amount by product item, an intermediate total by product group, and a major total by customer number.
2. Sort cards in ascending order.
3. Print an asterisk after major totals.
4. Detail print.
5. Form Layout:

Customer No.	*Product Group Item*	*Sales Amount*

Problem XV-1

1. Use the report headings given in problem XIV-1.
2. Add NX58 cards; subtract X58 cards; print a CR symbol for negative amounts.
3. Take a minor total of sales amount by invoice number. Print an asterisk after minor totals.
4. Detail print.

Problem XVI-1

1. Print the sales amount from those cards for salesmen 2, 3, and 4. Use column 33 of the salesman field.
2. Detail print.

3. Form Layout:

Product Number	*Salesman 2*	*Salesman 3*	*Salesman 4*

Problem XVI-2

1. Add sales cards (NX58) in one counter and add sales return cards (X58) in another counter.
2. Detail print.
3. Take a minor total by invoice number.
4. Form Layout:

Invoice Number	*Product Number*	*Sales Amount*	*Sales Returns*

Problem XVI-2A

Emit the current date for returns.

Problem XVII-1

1. Take a minor total on cost amount using invoice number as the control.
2. Add NX78 cards and subtract X78 cards. Print CR by negative amounts and totals and an asterisk after totals.
3. Detail print with group indication on invoice number.
4. Form Layout:

Invoice Number	*Product Number*	*Product Description*	*Cost Amount*

5. Do the group indication section of the problem using a different method on each wiring.

Problem XVIII-1

1. Add NX78 cards and subtract X78 cards. Print a credit symbol by negative amounts.
2. Take a minor total on cost amount using invoice number as the control. Print an asterisk by totals.
3. Group print.
4. Form Layout:

Invoice Number	*Cost Amount*

Problem XVIII-2

Wire problem XVIII-1 for both detail and group printing by using setup change.

Problem XIX-1

1. Take a minor total on sales amount using product item for program control and an intermediate total using product group.
2. Sort the cards in ascending order.
3. Print an asterisk after intermediate totals.
4. Group print. Use the same typebars for both levels of totals.
5. Form Layout:

Customer Number	*Product Group*	*Product Item*	*Sales Amount*

Problem XIX-2

1. Use the information given in problem XIX-1 but take a major total also using customer number for program control.
2. Couple a two- and a six-place counter to form an eight-place counter for the major totals.
3. Group indicate where needed.

Problem XIX-3

Use the information given in problems XIX-1 and XIX-2 but print totals in different typebars.

Problem XX-1

1. The amount field is sales amount for X78 cards and cost amount for NX78 cards.
2. Detail print.
3. Form Layout:

Product No.	*Product Description*	*Amount*

Problem XXI-1

1. List sales amount from NX58 cards in the sales column and sales amount from X58 cards in the returns column.
2. Detail print.
3. Form Layout:

Product No.	*Sales*	*Sales Returns*

Problem XXII-1

The cards for the crossfooting problem must be punched. Use the explanation given under Division XXII for the problem.

A	+	B	−	C	=	R
3		5		2		6
9		3		2		10
5		2		1		6

Problem XXIII-1

1. Use the information given in problem XIX-1 but take a major total using customer number for program control.
2. Summary punch the major total for each customer.

Problem XXIV-1

1. Each student should punch a name card, a street address card, and a city and state address card. Use card columns 1 through 30 for the name and address fields.
2. Have students print name and address labels for the class.

DIVISION XXXVI: PROGRAMMING PRACTICE SET

The programs in this practice set are intended to give the student practice coding the computer language and flowcharting the logic of a program.

The first two programs are to permit the student to become familiar with the language and the machine. The logic of these programs is not involved and this allows the student to concentrate on the coding of the computer language. The other programs in this practice set are designed to fit together into a system. The programs can be modified to fit the needs of the computer system and the student.

CARD FORMATS

Inventory Balance Card

Card Columns	*Number of Columns*
1- 5—Item Number	5
6-25—Item Description	20
26-28—Quantity	3
29-33—Amount	5
80 —Code (1)	1

Sale Card

Card Columns	*Number of Columns*
1- 5—Item Number	5
6-25—Item Description	20
26-28—Quantity	3
34-38—Amount	5
39-43—Customer Number	5
44-63—Customer Name	20
64-65—Branch Code	2
66-67—Salesman Code	2
68-72—Invoice Number	5
73-78—Invoice Date	6
80 —Code (2)	1

Purchase Card

Card Columns	*Number of Columns*
1- 5—Item Number	5
6-25—Item Description	20
26-28—Quantity	3
34-38—Purchase Amount	5
39-43—Vendor Number	5
44-63—Vendor Name	20
68-72—Purchase Order Number	5
73-78—Purchase Order Date	6
80 —Code (3)	1

Payroll Master Card

Card Columns	*Number of Columns*
1- 5—Employee's Number	5
6-25—Employee's Name	20
31-33—Regular Rate	3
34-36—Overtime Rate	3
37-43—Total Gross Pay	7
44-50—Total FICA	7
51-57—Total Withholding Tax (Federal)	7
58-64—Total Withholding Tax (State)	7
65-71—Group Insurance	7
80 —Code (4)	1

Payroll Time Card

Card Columns	*Number of Columns*
1- 5—Employee's Number	5
6-25—Employee's Name	20
26-28—Number of Hours—Reg.	3
29-31—Number of Overtime Hours	3
32-35—Group Insurance (Amt.)	4
80 —Code (5)	1

Accounts Receivable Balance Cards

Card Columns	*Number of Columns*
34-38—Amount	5
39-43—Customer Number	5
44-63—Customer Name	20
80 —Code (6)	1

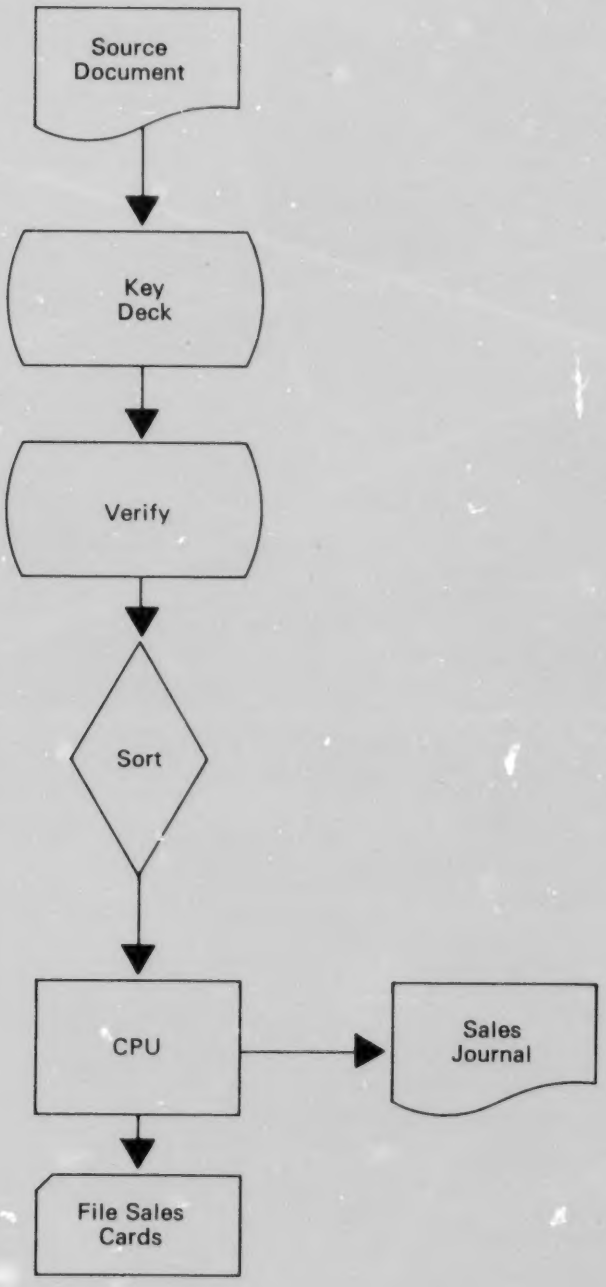
Accounts Receivable Payment Card

Card Columns	*Number of Columns*
34-38—Amount	5
39-43—Customer Number	5
44-63—Customer Name	20
80 —Code (7)	1

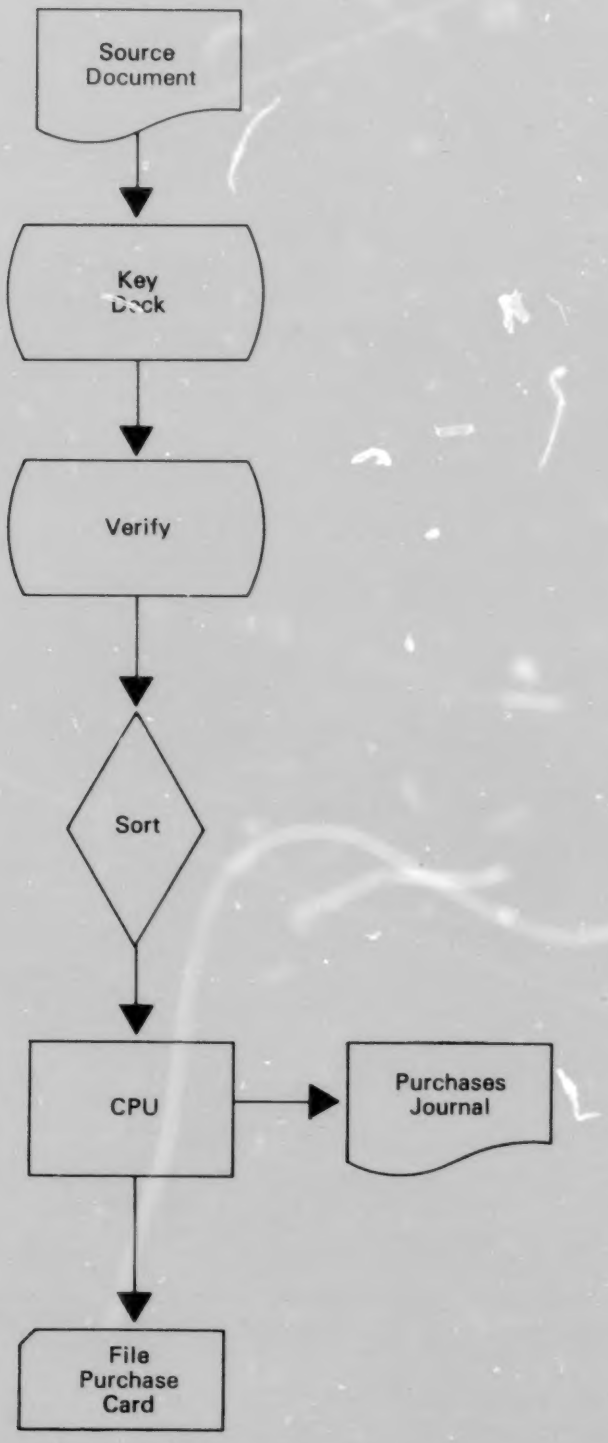
Salesman Master Card

Card Columns	*Number of Columns*
31-38—Sales to Date	8
44-63—Salesman Name	20
66-67—Salesman Code	2
80 —Code (8)	1

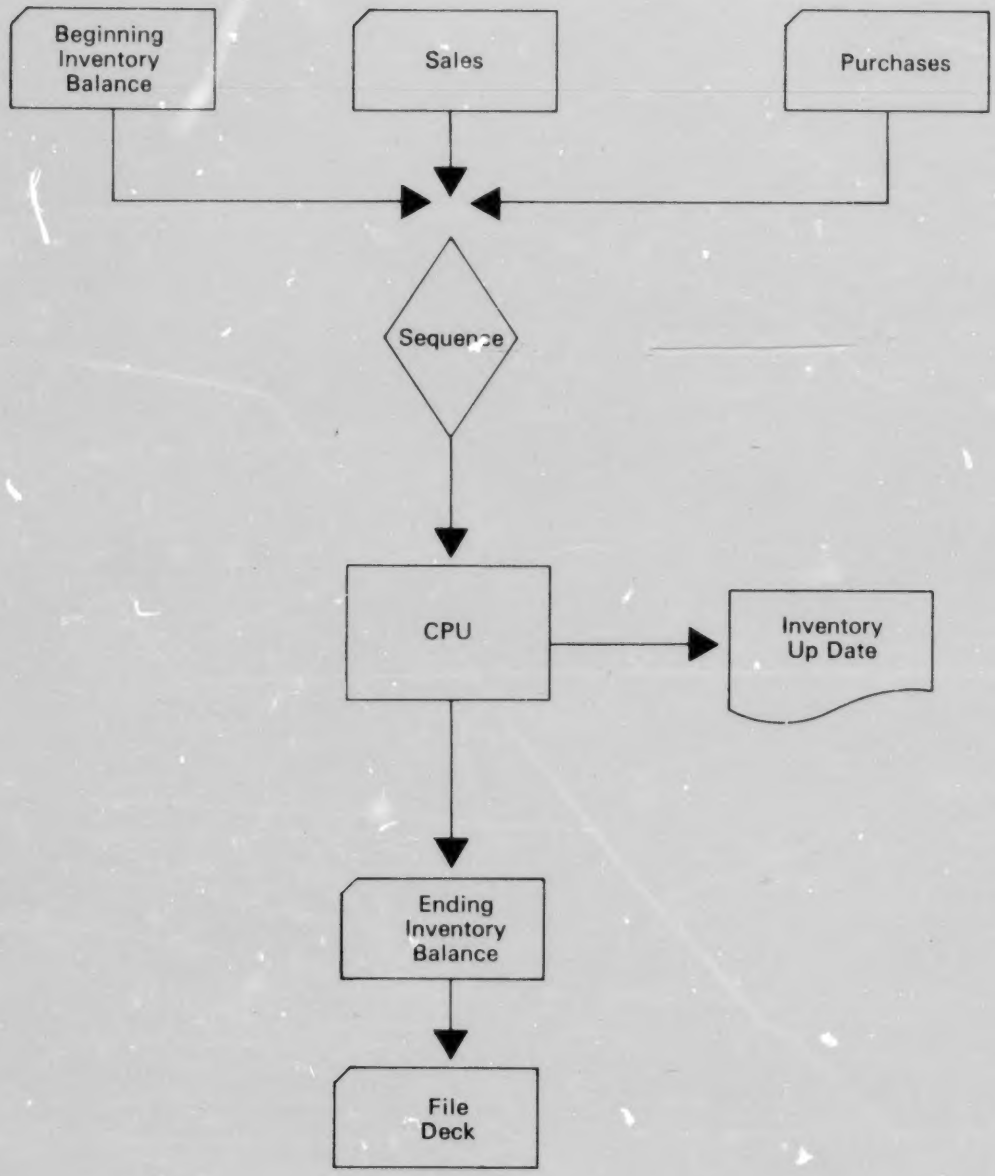
SYSTEM FLOWCHART — SALES JOURNAL



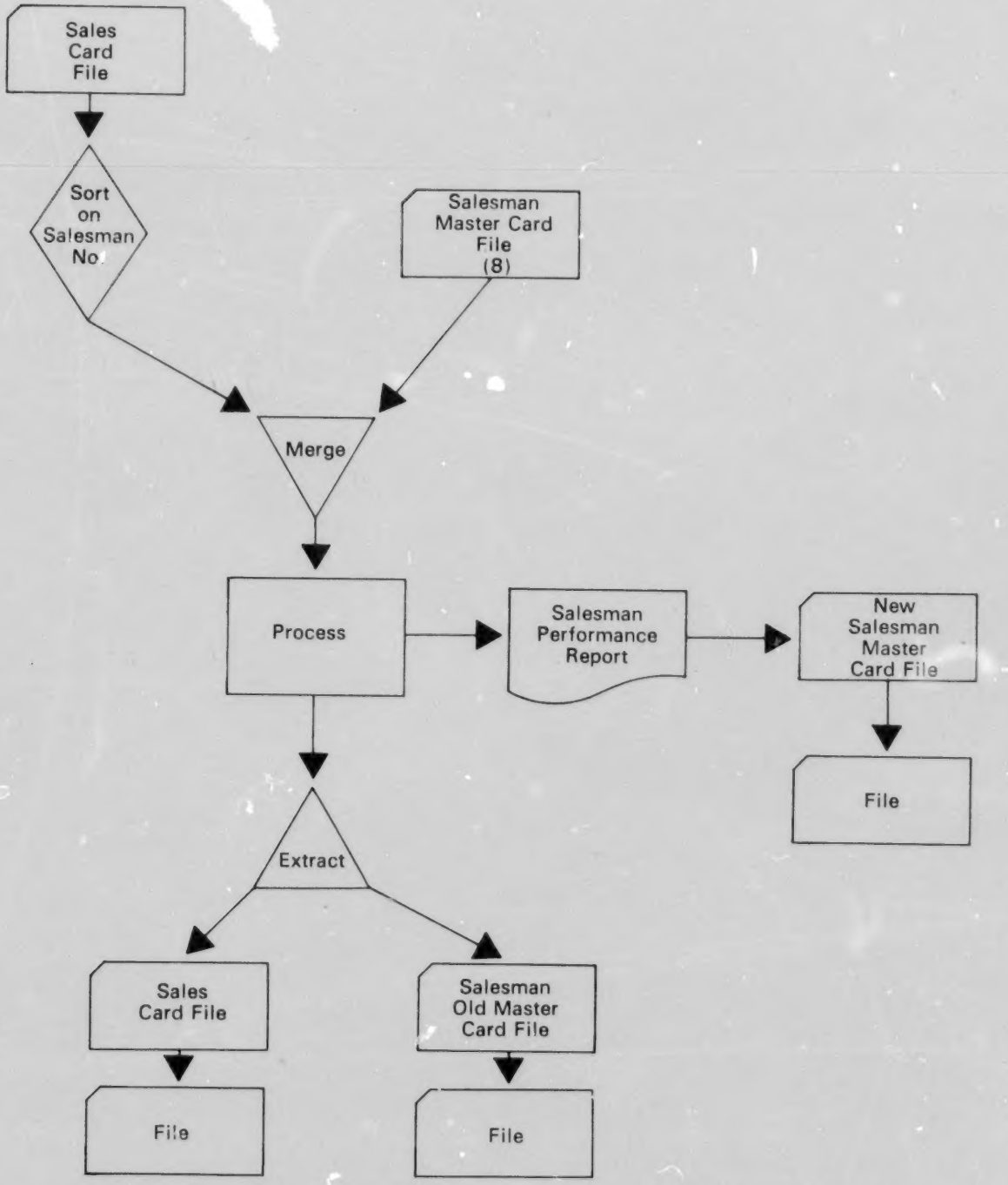
SYSTEM FLOWCHART — PURCHASES JOURNAL



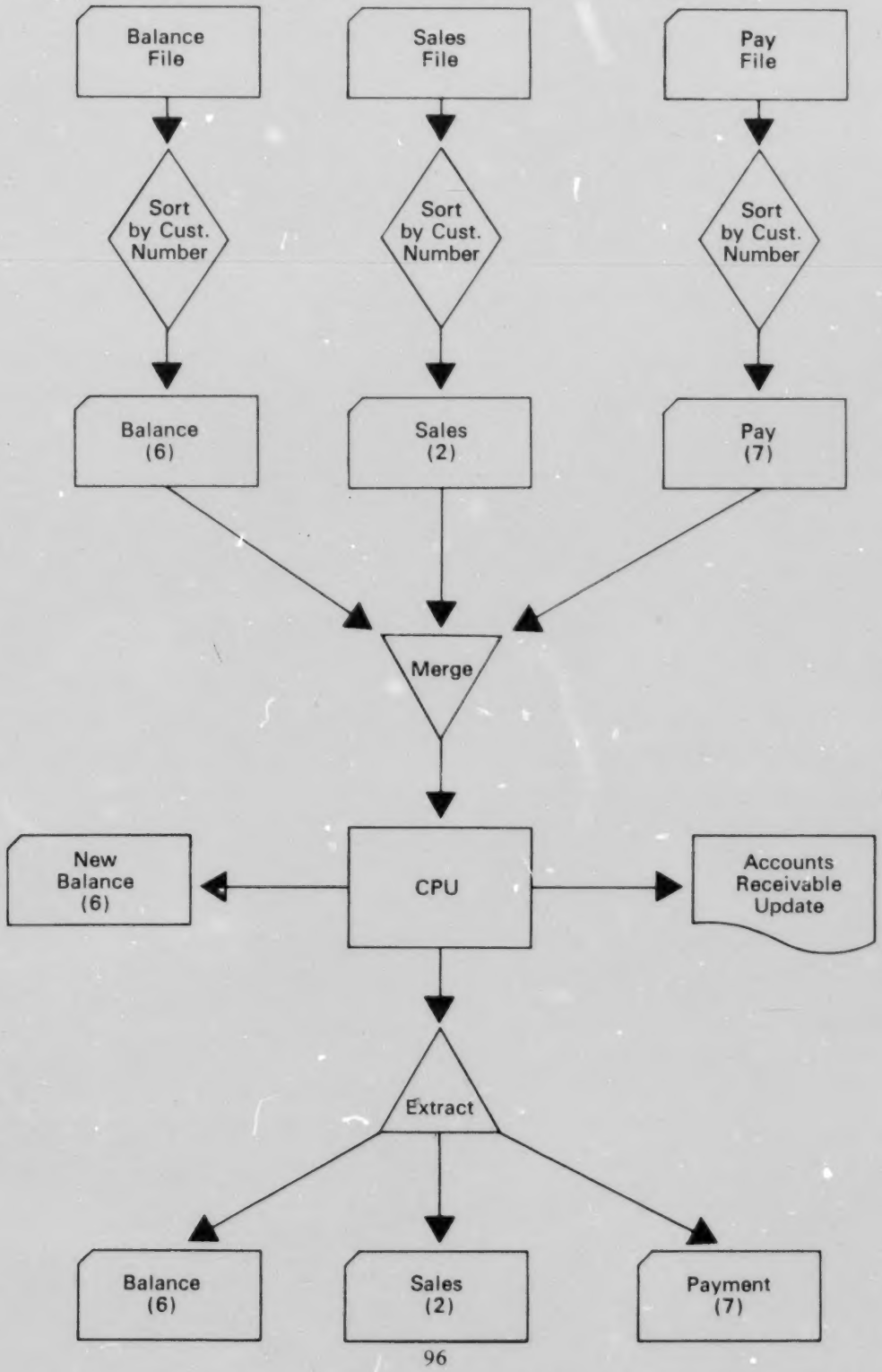
SYSTEM FLOWCHART — INVENTORY UPDATE



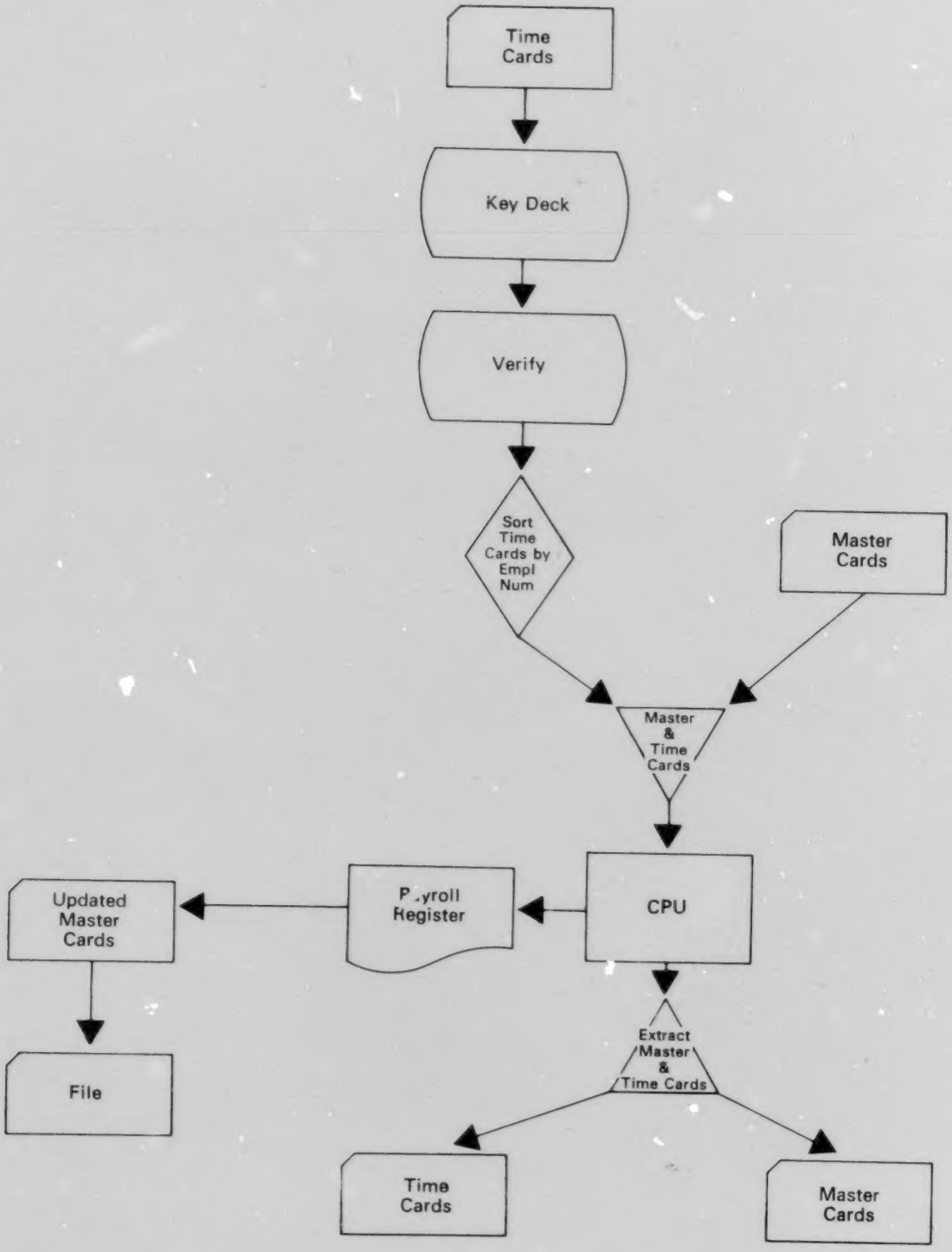
SYSTEM FLOWCHART FOR SALES ANALYSIS



SYSTEM FLOWCHART FOR ACCOUNTS RECEIVABLE



SYSTEM FLOWCHART FOR PAYROLL



80/80 LIST—PROGRAM 1

PROGRAM DESCRIPTION

Input:

Card Reader—(any card deck)

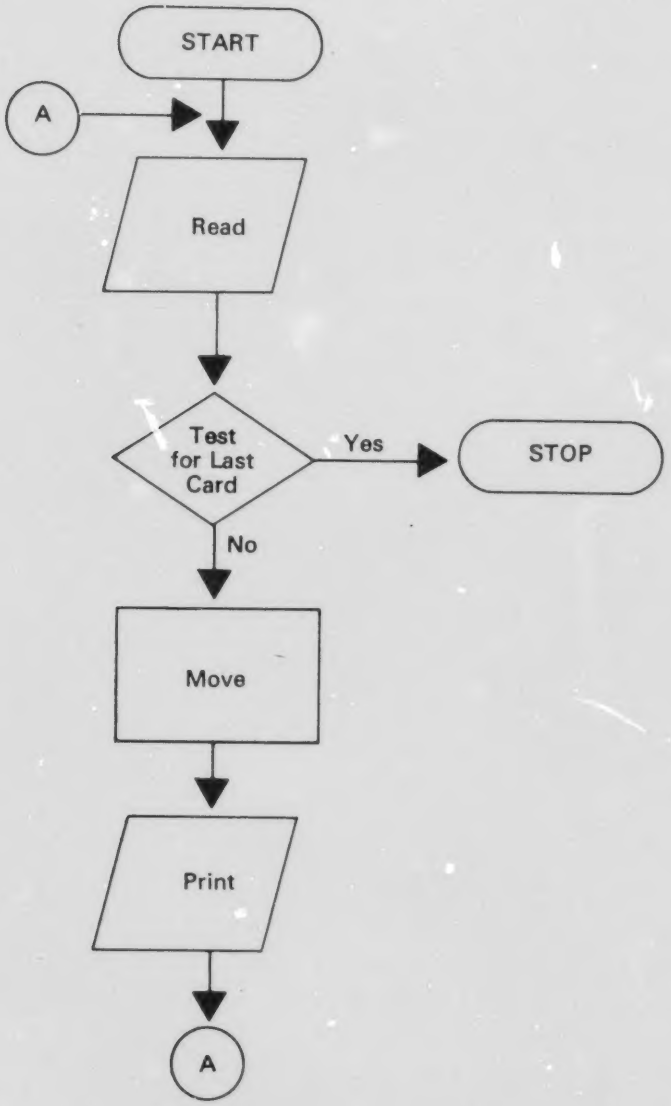
Output:

Printer—80/80 Listing

Processing:

This program lists cards on the printer. There is one line of print for each card.

DETAIL FLOWCHART — 80/80 LIST



LISTING PROGRAM WITH HEADINGS—PROGRAM 2

PROGRAM DESCRIPTION

Input:

Card Reader—(any card deck)

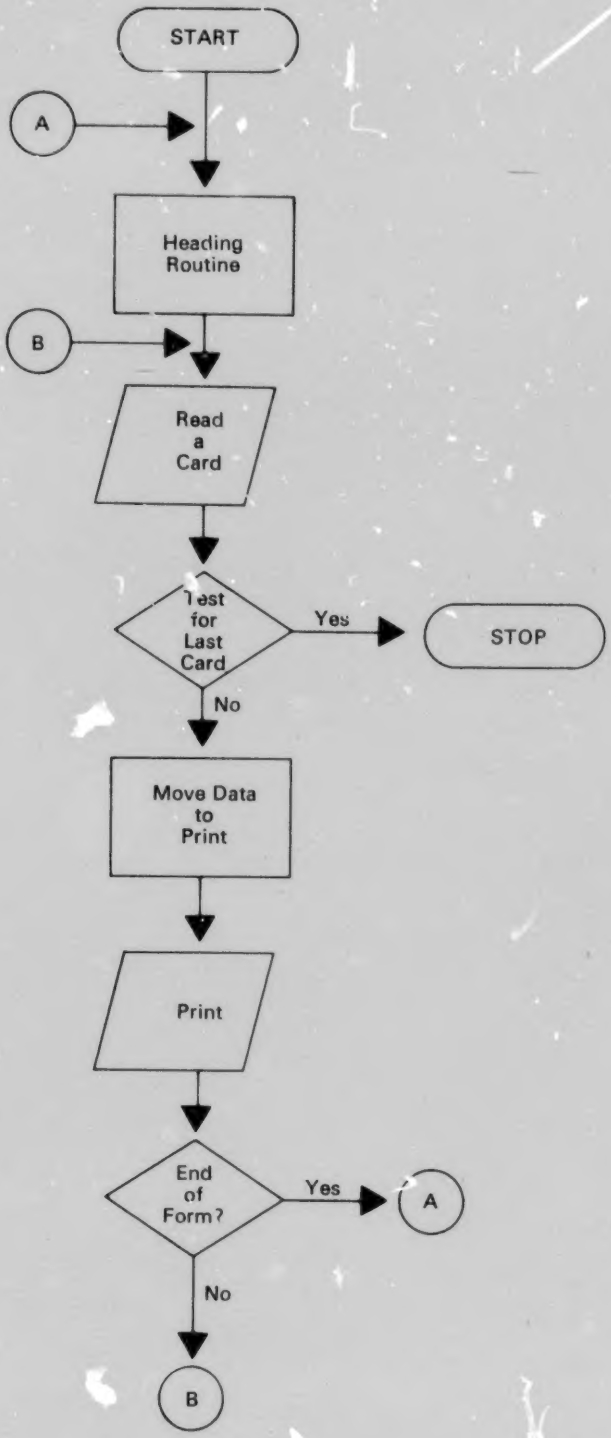
Output:

Printer—Listing

Processing:

This program prints one line of print for each card. The program should also print a heading at the top of each page.

DETAIL FLOWCHART OF LISTING PROGRAM WITH HEADINGS



SALES JOURNAL—PROGRAM 3

PROGRAM DESCRIPTION

Input:

Card Reader—Sales (2) cards

Output:

Printer—Sales Journal

Processing:

The sales cards should be sorted by customer number. The program should include a final total of the amount field.

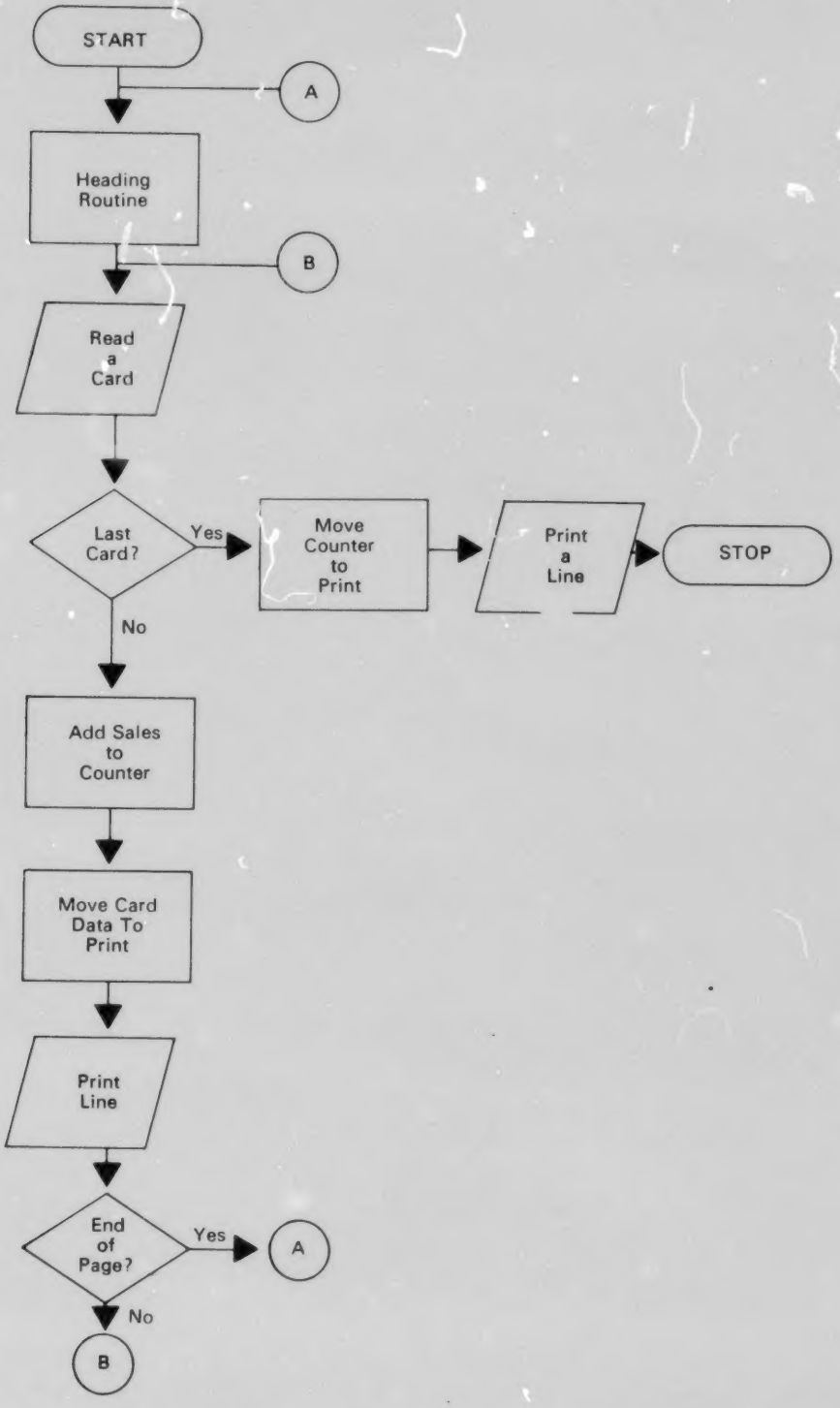
Some possible error conditions which can be checked are sequence and invalid code.

Printer Layout:

SALES JOURNAL

INVOICE NO.	DATE	CUSTOMER NO.	NAME	ITEM NO.	DESCRIPTION	AMOUNT

DETAIL FLOWCHART FOR SALES JOURNAL



PURCHASES JOURNAL—PROGRAM 4

PROGRAM DESCRIPTION

Input:

Card Reader—Purchase (3) cards

Output:

Printer—Purchase Journal

Processing:

The purchase cards should be sorted by vendor number. The program should include a final total of the amount field.

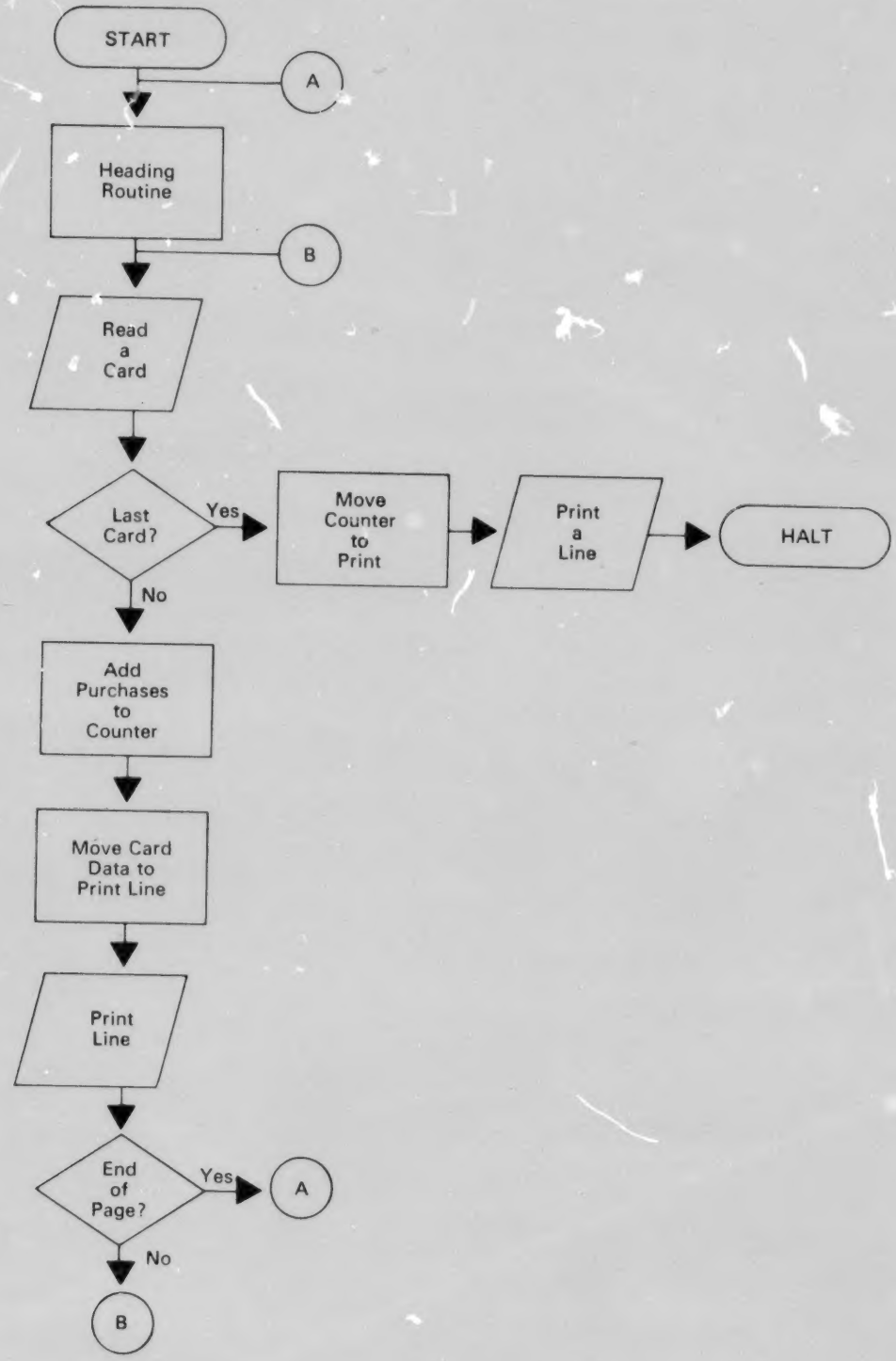
Some possible error conditions which can be checked are sequence, and invalid code.

Printer Layout:

PURCHASE JOURNAL

PURCHASE ORDER NO.	PURCHASE ORDER DATE	VENDOR NUMBER	VENDOR NAME	ITEM NO.	ITEM DESCRIPTION	AMOUNT

DETAiL FLOWCHART FOR PURCHASES JOURNAL



INVENTORY SUMMARY—PROGRAM 5

PROGRAM DESCRIPTION

Input:

Card Reader—Sales (2), Purchases (3), and Balance (1) cards

Output:

Printer—Inventory Summary

Card Punch—New Balance cards (1)

Processing:

The cards should be sorted by item number. There can be an unlimited number of sales and purchases cards but there should not be more than one balance card for each item. Sequence within item number makes no difference.

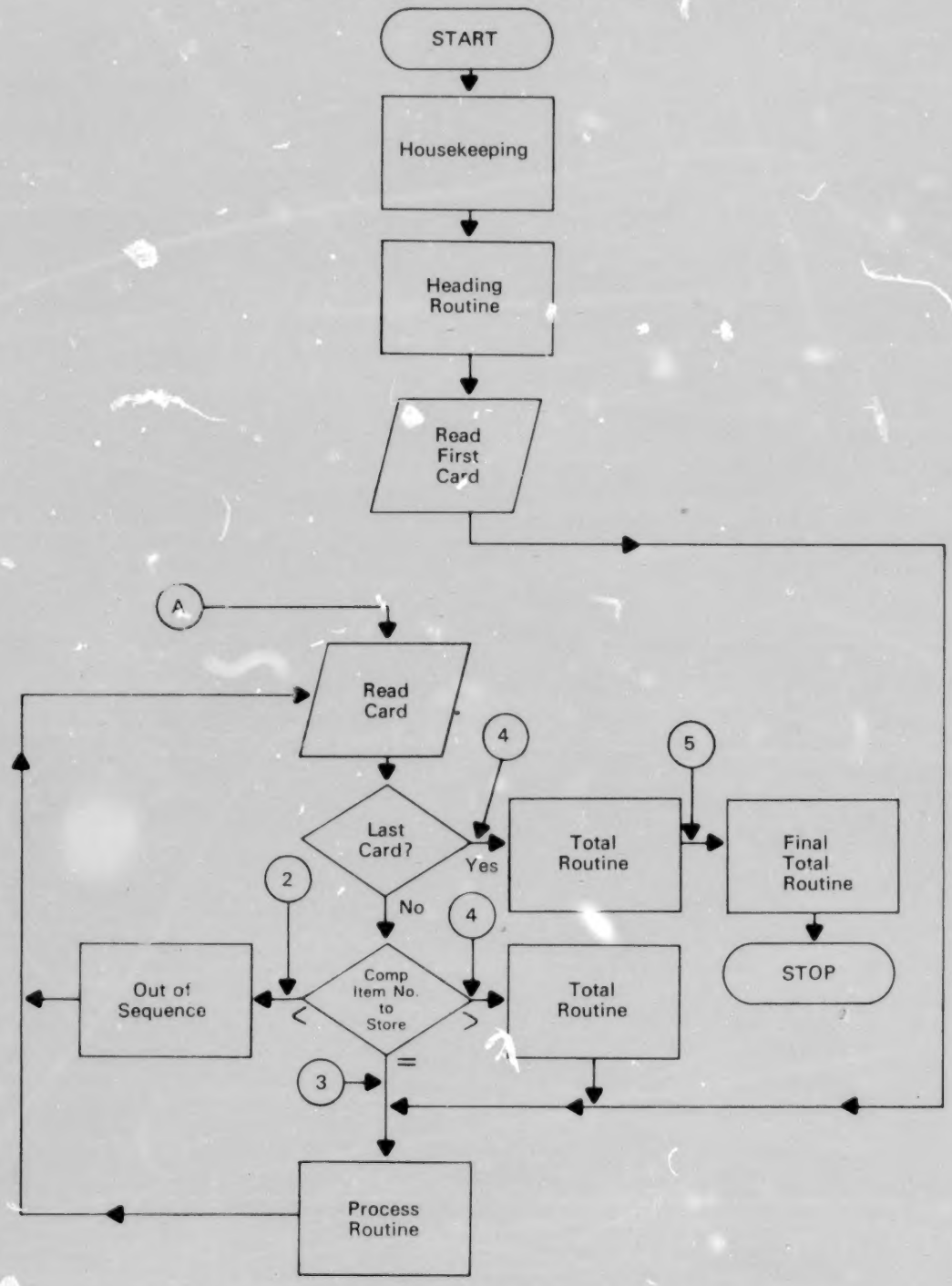
Some possible error conditions which can be checked in the program are sequence, invalid code, non-numeric fields, and more than one balance per item.

Printer Layout:

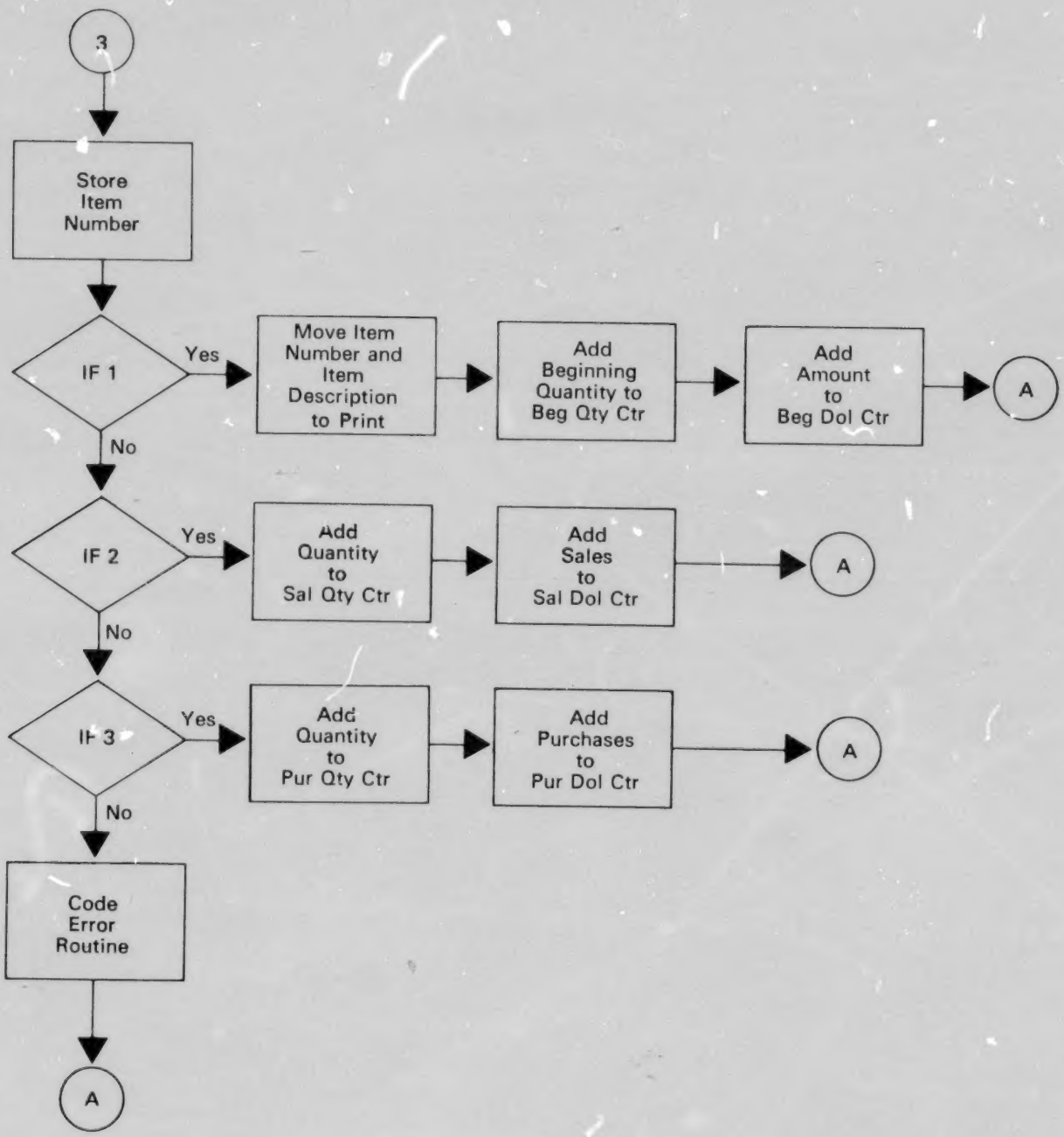
INVENTORY SUMMARY

		QUANTITY				DOLLARS		VALUE	
ITEM NUMBER	ITEM DESCRIPTION	BEGINNING	PURCHASES	SALES	ENDING	BEGINNING	PURCHASES	SALES	ENDING
	(COUNTER TITLES)	(BEG QTY CTR)	(PUR QTY CTR)	(SAL QTY CTR)	(END QTY CTR)	(BEG DOL CTR)	(PUR DOL CTR)	(SAL DOL CTR)	(END DOL CTR)

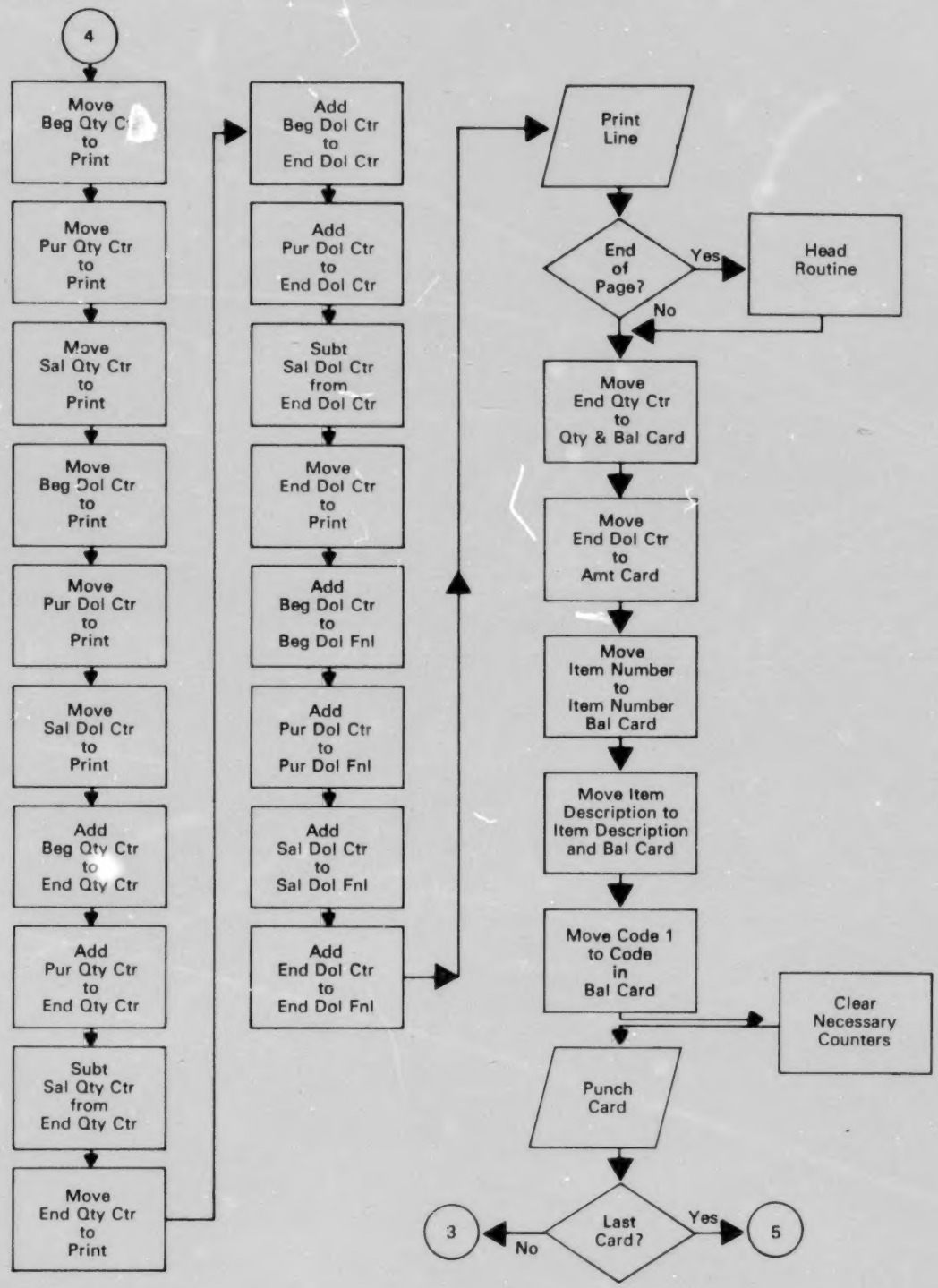
MAIN LINE
FLOWCHART — INVENTORY UPDATE



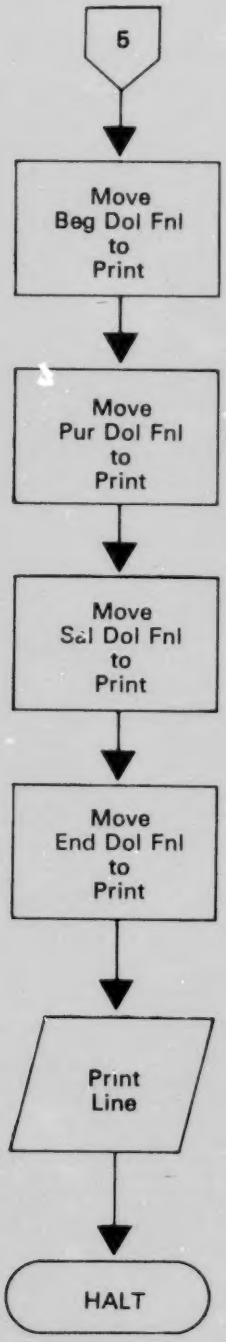
DETAIL FLOWCHART
PROCESS ROUTINE INVENTORY



DETAIL FLOWCHART — TOTAL ROUTINE INVENTORY


4
Move Beg Qty Ctr to Print
Move Pur Qty Ctr to Print
Move Sal Qty Ctr to Print
Move Beg Dol Ctr to Print
Move Pur Dol Ctr to Print
Move Sal Dol Ctr to Print
Add Beg Qty Ctr to End Qty Ctr
Add Pur Qty Ctr to End Qty Ctr
Subt Sal Qty Ctr from End Qty Ctr
Move End Qty Ctr to Print
Add Beg Dol Ctr to End Dol Ctr
Add Pur Dol Ctr to End Dol Ctr
Subt Sal Dol Ctr from End Dol Ctr
Move End Dol Ctr to Print
Add Beg Dol Ctr to Beg Dol Fnl
Add Pur Dol Ctr to Pur Dol Fnl
Add Sal Dol Ctr to Sal Dol Fnl
Add End Dol Ctr to End Dol Fnl
Print Line
End of Page?
Yes
Head Routine
No
Move End Qty Ctr to Qty & Bal Card
Move End Dol Ctr to Amt Card
Move Item Number to Item Number Bal Card
Move Item Description to Item Description and Bal Card
Move Code 1 to Code in Bal Card
Clear Necessary Counters
Punch Card
Last Card?
Yes
No
3
5

DETAIL FLOWCHART — FINAL TOTAL ROUTINE INVENTORY



SALES ANALYSIS—PROGRAM 6

PROGRAM DESCRIPTION

Input:

Card Reader—Sales (2), and Salesman master (8) cards

Output:

Printer—Sales Analysis Report

Processing:

This program computes previous, current and total sales for each salesman. The sales cards (2) should be sorted by salesman code and merged with the salesman master cards (8). There should be one master for each salesman.

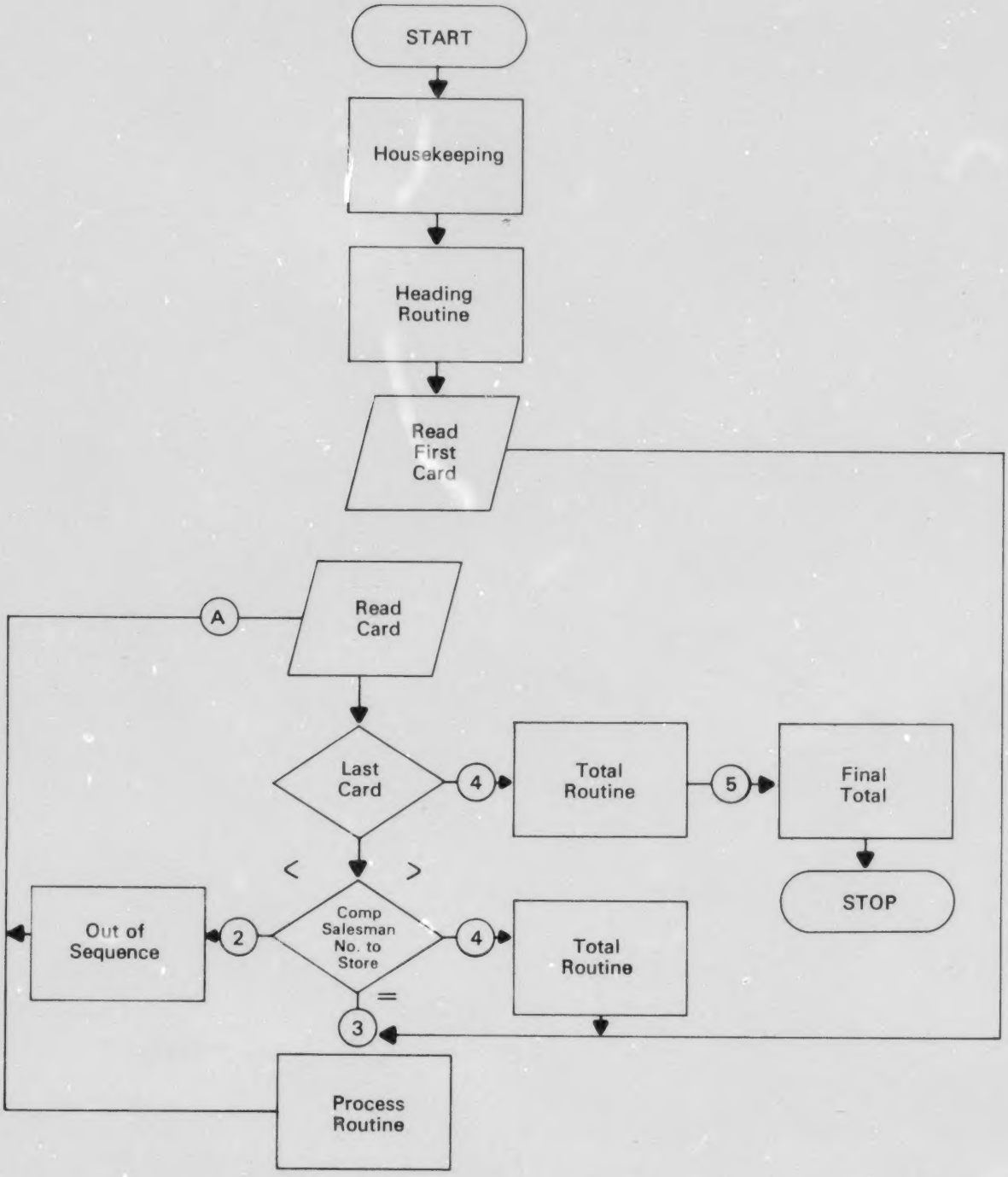
Some possible error conditions which can be checked in the program are: sequence, invalid code, and sales cards with no master card.

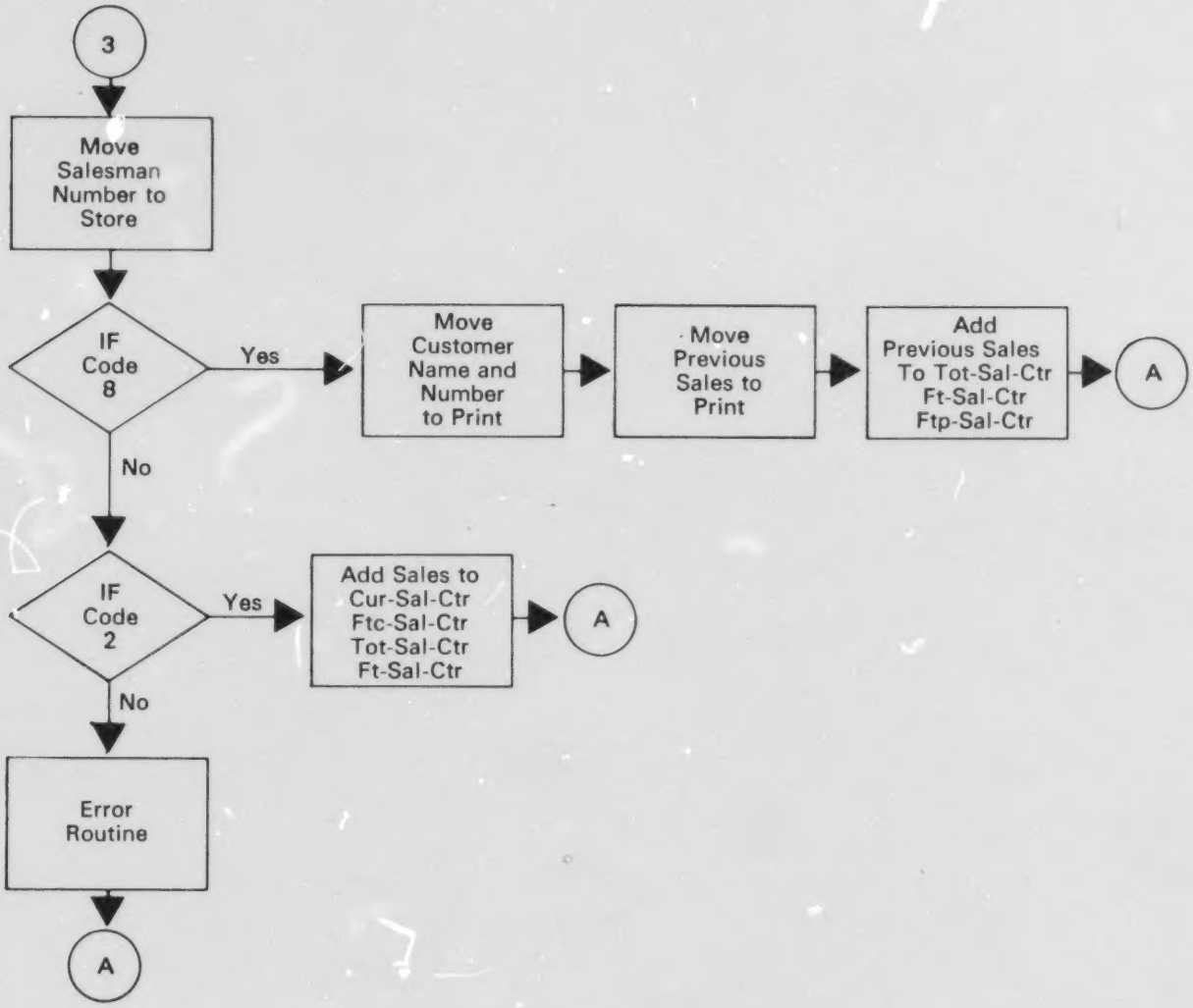
Printer Layout:

SALES ANALYSIS BY SALESMAN

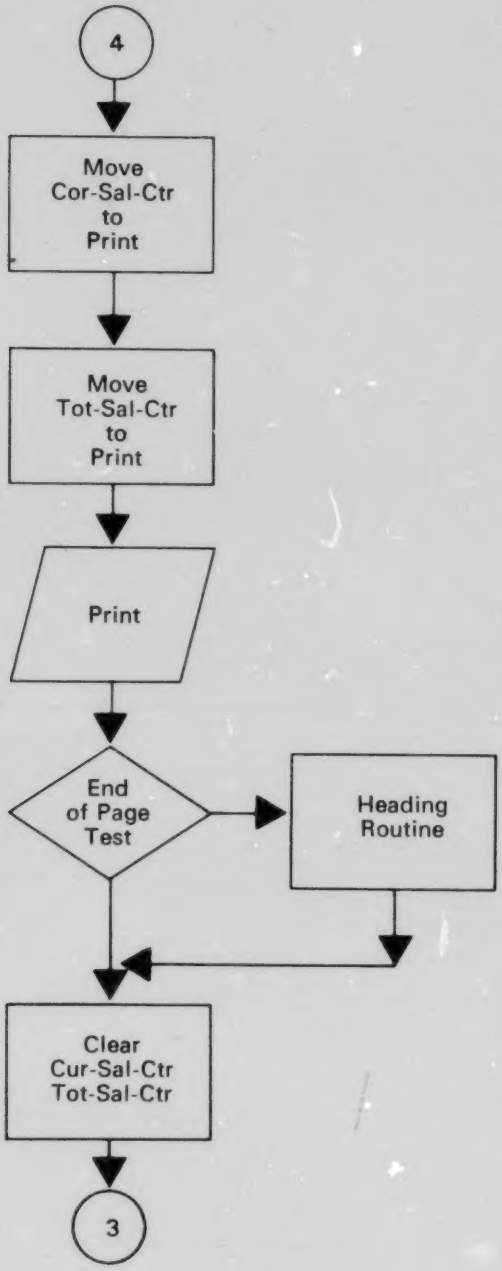
SALESMAN NUMBER	SALESMAN NAME	PREVIOUS SALES	CURRENT SALES	TOTAL SALES TO DATE
	(COUNTERS)	(FTP-SAL-CTR)	(CUR-SAL-CTR / FTC-SAL-CTR)	(TOT-SAL-CTR / FT-SAL-CTR)

MAIN LINE FOR SALES ANALYSIS

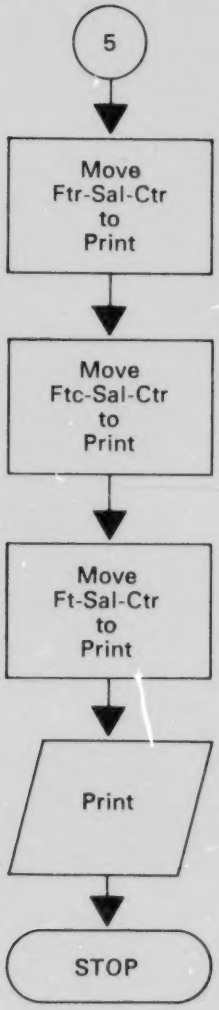



3
Move Salesman Number to Store
IF Code 8
Yes
Move Customer Name and Number to Print
Move Previous Sales to Print
Add Previous Sales To Tot-Sal-Ctr Ft-Sal-Ctr Ftp-Sal-Ctr
A
No
IF Code 2
Yes
Add Sales to Cur-Sal-Ctr Ftc-Sal-Ctr Tot-Sal-Ctr Ft-Sal-Ctr
A
No
Error Routine
A

TOTAL RO /TINE — SALES ANALYSIS



FINAL TOTAL ROUTINE — SALES ANALYSIS



ACCOUNTS RECEIVABLE—PROGRAM 7

PROGRAM DESCRIPTION

Input:

Card Reader—Payment (7), Balance (6), and Sales (2) cards

Output:

Printer—Accounts Receivable Report

Card Punch—New Balance Card (6)

Processing:

The cards should be in sequence by customer number, but sequence within customer number makes no difference. There must be one balance card for each customer, but there is no limit to the number of sales and purchase cards for each customer.

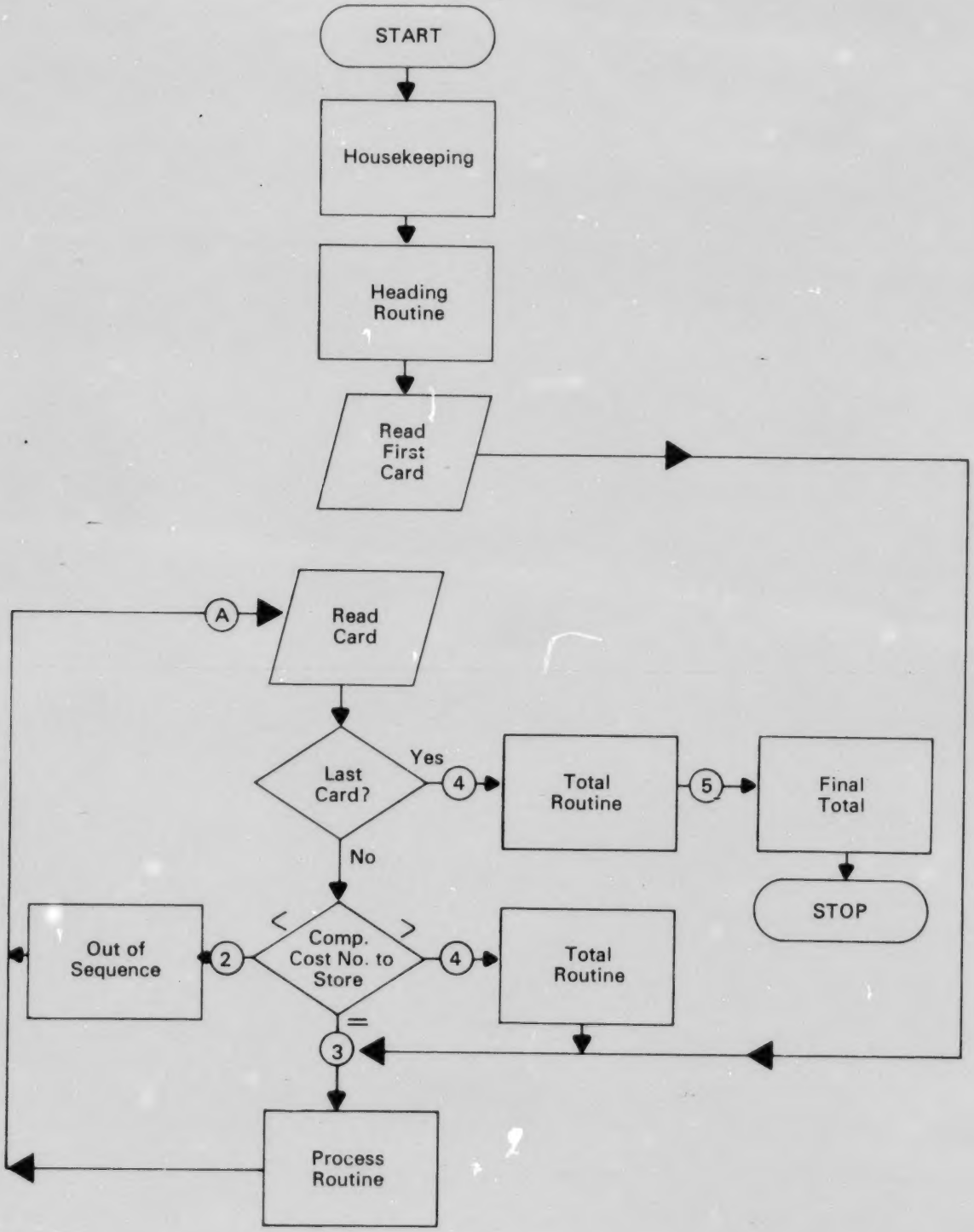
Possible error conditions include sequence in customer number, invalid code, non-numeric fields, and sales or purchase cards with no master card.

Printer Layout:

ACCOUNTS RECEIVABLE SUMMARY

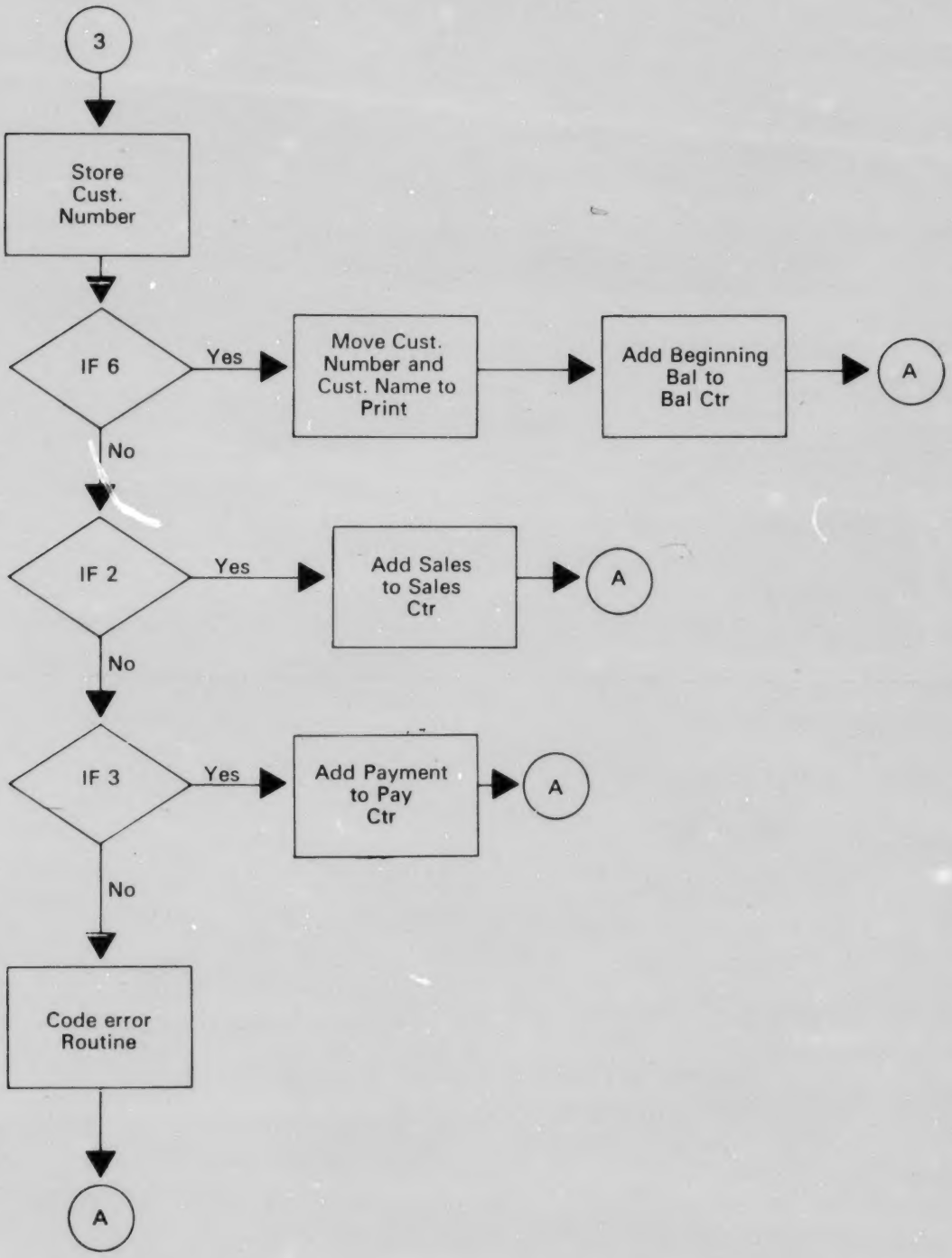
CUSTOMER NUMBER	CUSTOMER NAME	BEGINNING BALANCE	SALES	PAYMENTS	ENDING BALANCE
(COUNTERS USED)		BAL-CTR BAL-FNL	SALES-CTR SALES-FNL	PAY-CTR PAY-FNL-CTR	END-BAL-CTR END-BAL-FNL

MAIN LINE ROUTINE FOR ACCOUNTS RECEIVABLE



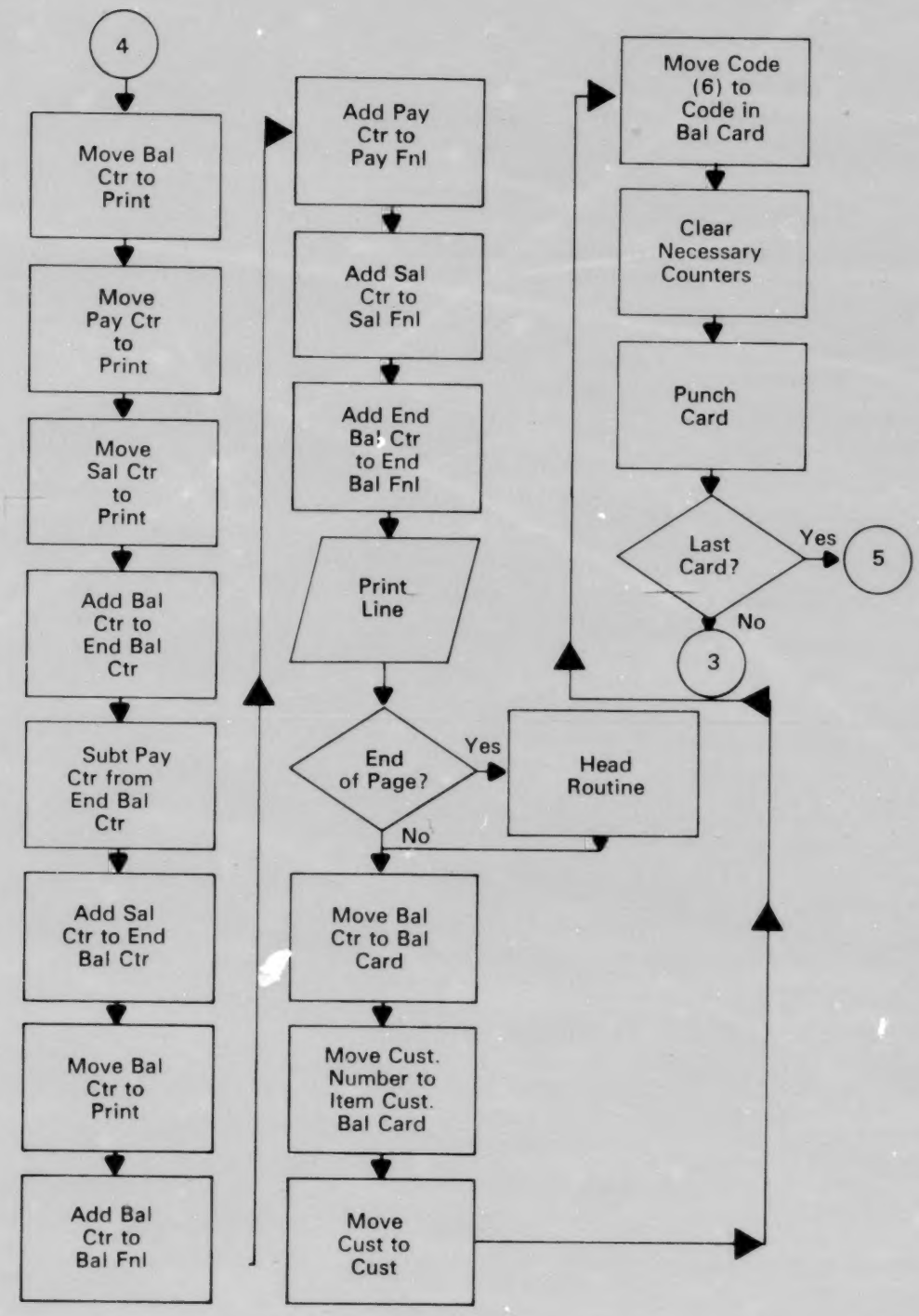
127

PROCESS ROUTINE — ACCOUNTS RECEIVABLE

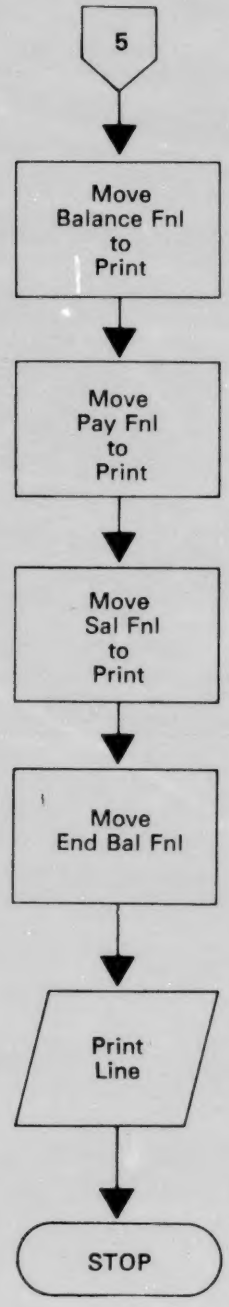


128

TOTAL ROUTINE — ACCOUNTS RECEIVABLE


4
Move Bal Ctr to Print
Move Pay Ctr to Print
Move Sal Ctr to Print
Add Bal Ctr to End Bal Ctr
Subt Pay Ctr from End Bal Ctr
Add Sal Ctr to End Bal Ctr
Move Bal Ctr to Print
Add Bal Ctr to Bal Fnl
Add Pay Ctr to Pay Fnl
Add Sal Ctr to Sal Fnl
Add End Bal Ctr to End Bal Fnl
Print Line
End of Page?
Yes
No
Head Routine
Move Bal Ctr to Bal Card
Move Cust. Number to Item Cust. Bal Card
Move Cust to Cust
Move Code (6) to Code in Bal Card
Clear Necessary Counters
Punch Card
Last Card?
Yes
No
5
3

FINAL TOTAL ROUTINE — ACCOUNTS RECEIVABLE



PAYROLL—PROGRAM 8

PROGRAM DESCRIPTION

Input:

Card Reader—Master Payroll (4), Time (5) Cards

Output:

Printer—Payroll Summary

Punch—New Master Payroll (4) cards

Processing:

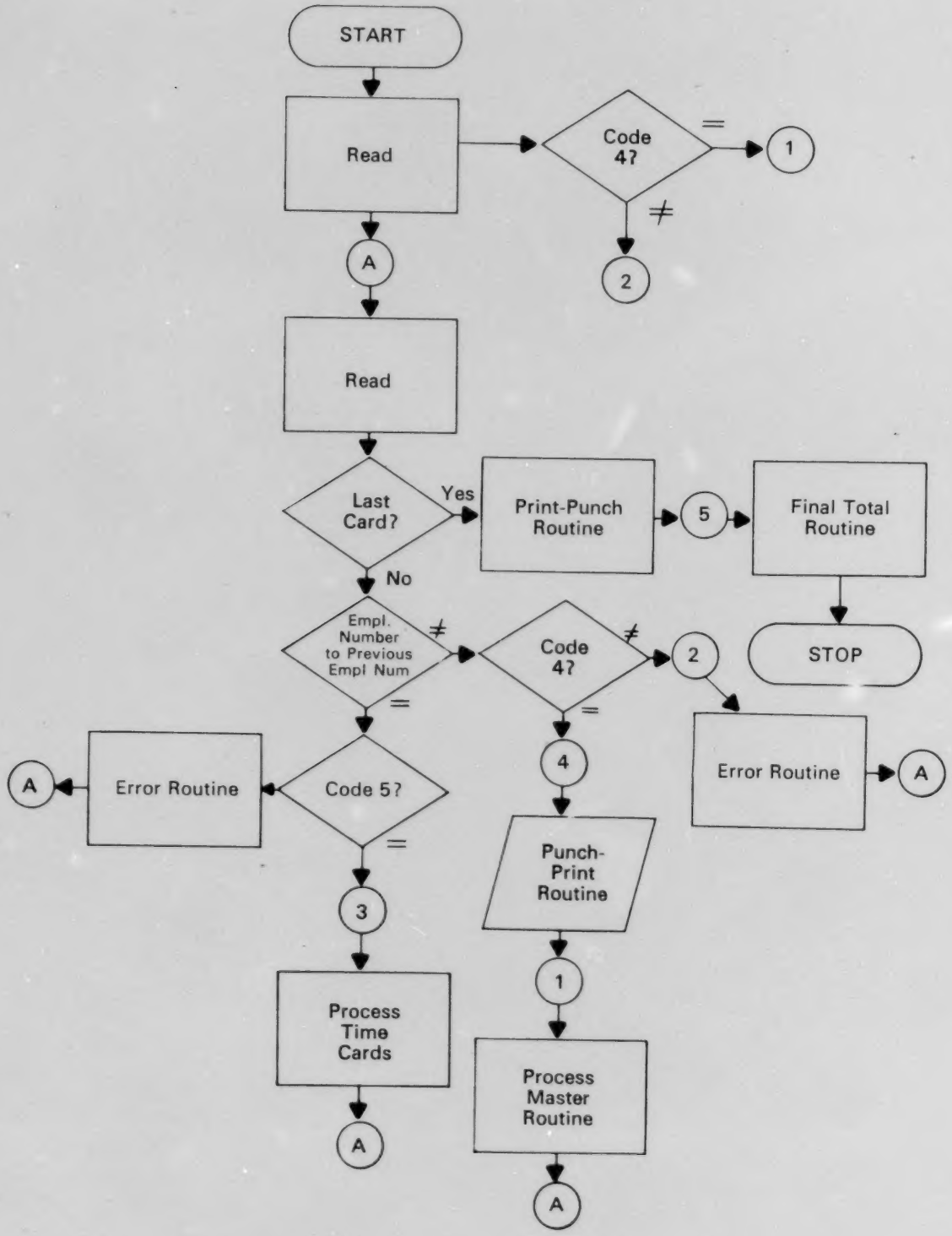
The time cards should be sorted by employee number and merged with Master Payroll cards. The method of computing taxes will be left to the instructor.

Printer Layout:

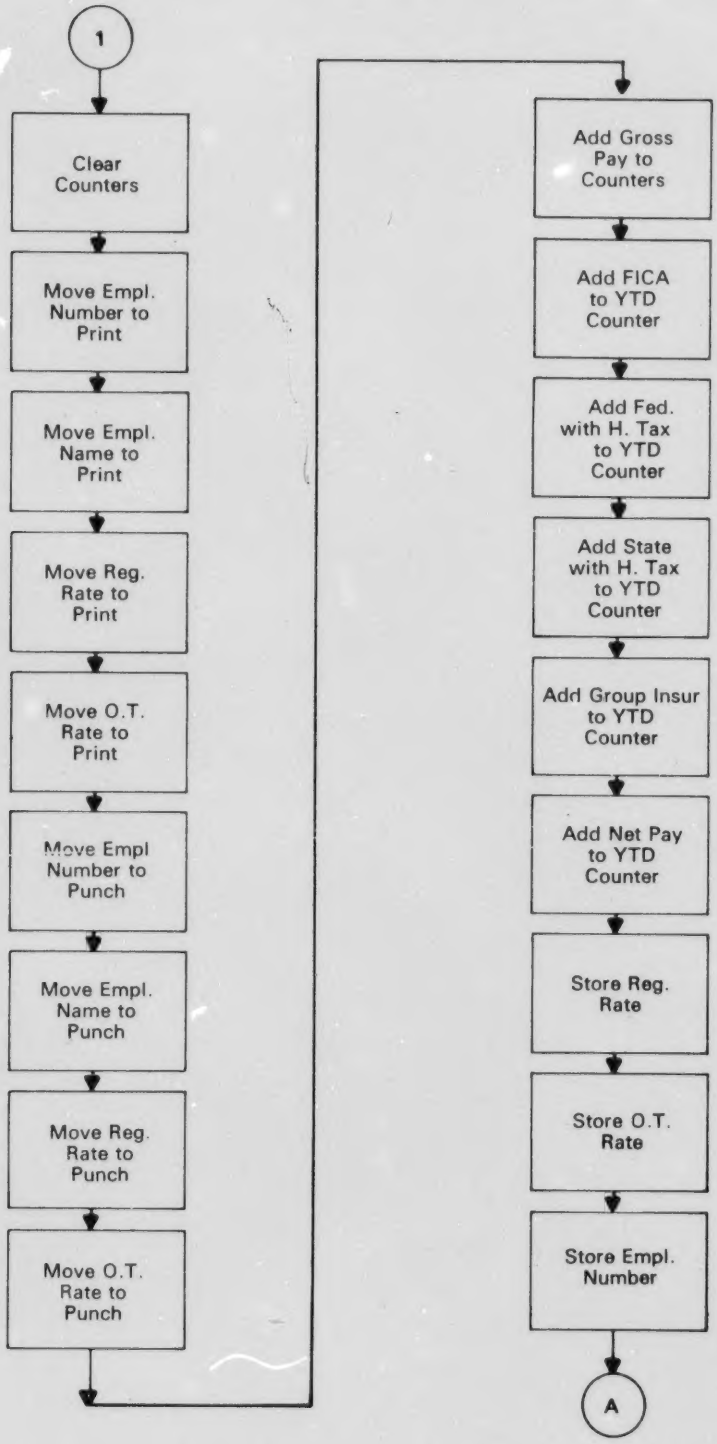
PAYROLL SUMMARY

EMPLOYEE NUMBER	EMPLOYEE NAME	REGULAR RATE	OVERTIME RATE	GROSS PAY		FICA		WITHHOLDING (FEDERAL)		WITHHOLDING (STATE)	
				CUR.	YR-TO-DATE	CUR.	YR-TO-DATE	CUR.	YR-TO-DATE	CUR.	YR-TO-DATE

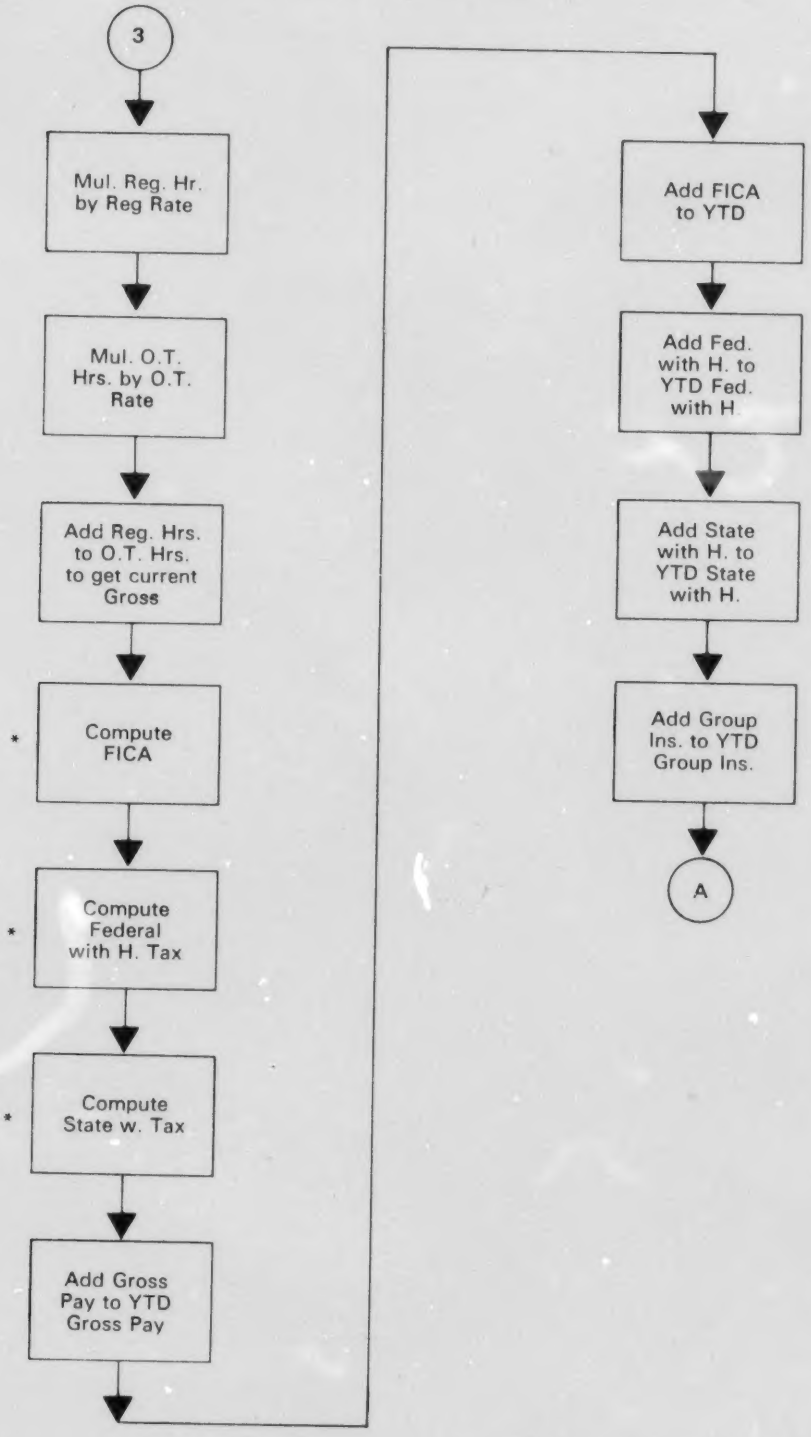
PAYROLL MAIN LINE ROUTINE



MASTER ROUTINE — PAYROLL

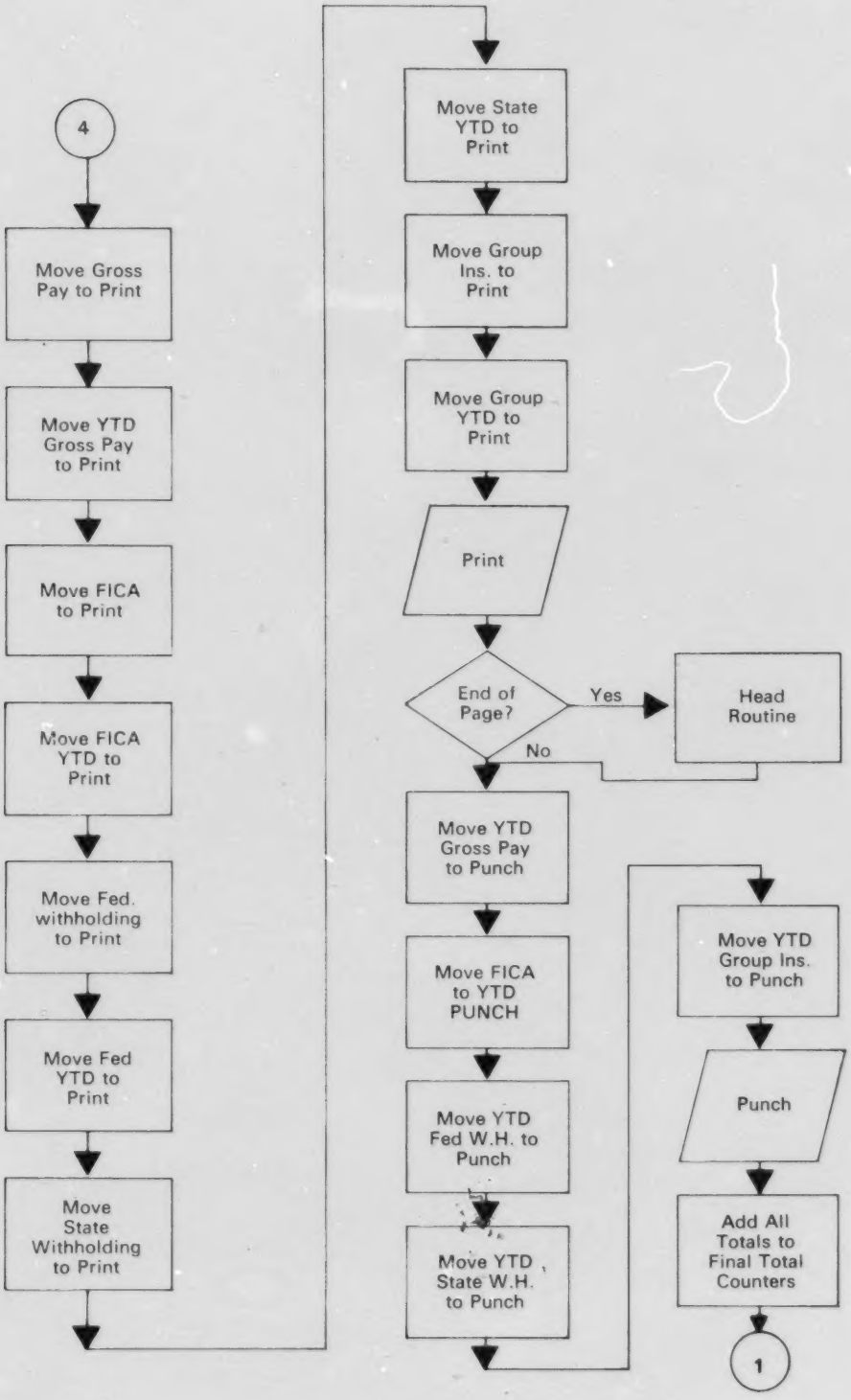

1
Clear Counters
Move Empl. Number to Print
Move Empl. Name to Print
Move Reg. Rate to Print
Move O.T. Rate to Print
Move Empl Number to Punch
Move Empl. Name to Punch
Move Reg. Rate to Punch
Move O.T. Rate to Punch
Add Gross Pay to Counters
Add FICA to YTD Counter
Add Fed. with H. Tax to YTD Counter
Add State with H. Tax to YTD Counter
Add Group Insur to YTD Counter
Add Net Pay to YTD Counter
Store Reg. Rate
Store O.T. Rate
Store Empl. Number
A

PROCESS TIME CARDS — PAYROLL

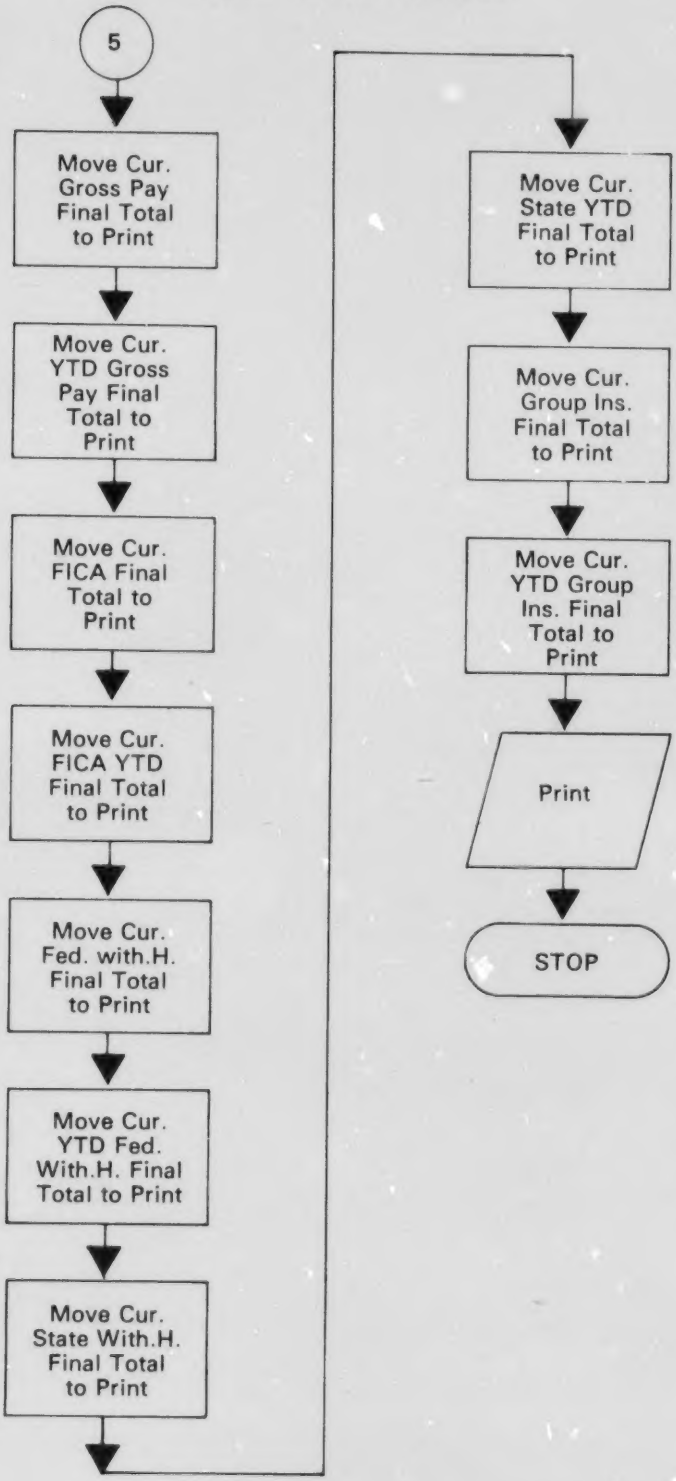

3
Mul. Reg. Hr. by Reg Rate
Mul. O.T. Hrs. by O.T. Rate
Add Reg. Hrs. to O.T. Hrs. to get current Gross
* Compute FICA
* Compute Federal with H. Tax
* Compute State w. Tax
Add Gross Pay to YTD Gross Pay
Add FICA to YTD
Add Fed. with H. to YTD Fed. with H
Add State with H. to YTD State with H.
Add Group Ins. to YTD Group Ins.
A

*NOTE: Method of computing is left to instructor.

PRINT — PUNCH PAYROLL


4
Move Gross Pay to Print
Move YTD Gross Pay to Print
Move FICA to Print
Move FICA YTD to Print
Move Fed. withholding to Print
Move Fed YTD to Print
Move State Withholding to Print
Move State YTD to Print
Move Group Ins. to Print
Move Group YTD to Print
Print
End of Page?
Yes
Head Routine
No
Move YTD Gross Pay to Punch
Move FICA to YTD PUNCH
Move YTD Fed W.H. to Punch
Move YTD State W.H. to Punch
Move YTD Group Ins. to Punch
Punch
Add All Totals to Final Total Counters
1

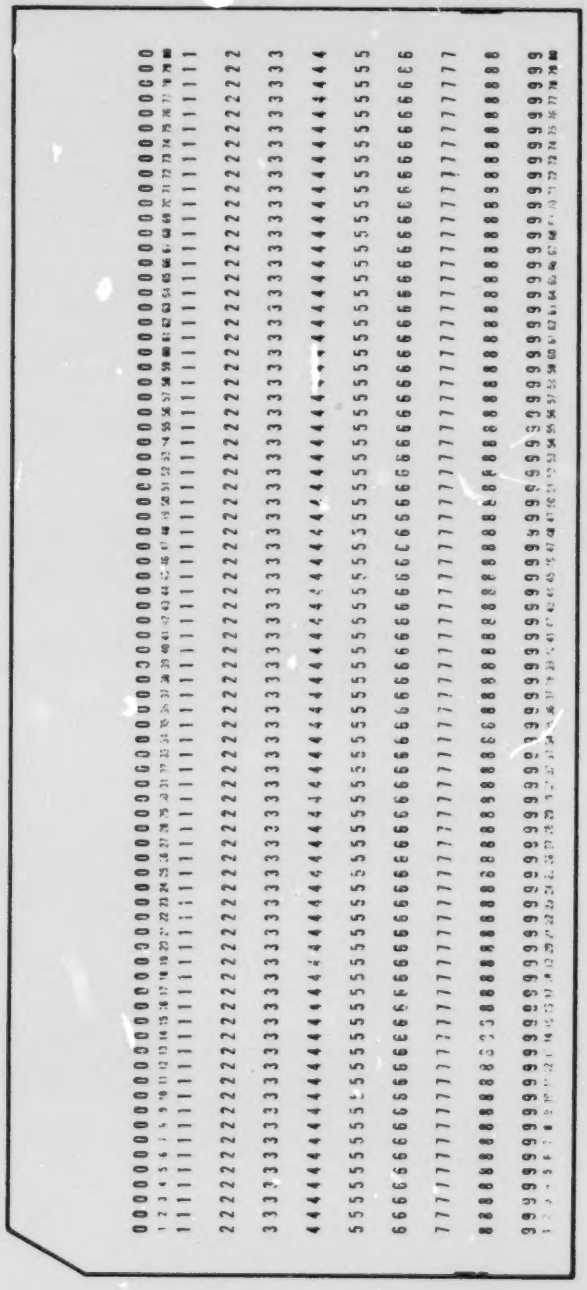
FINAL TOTAL PAYROLL

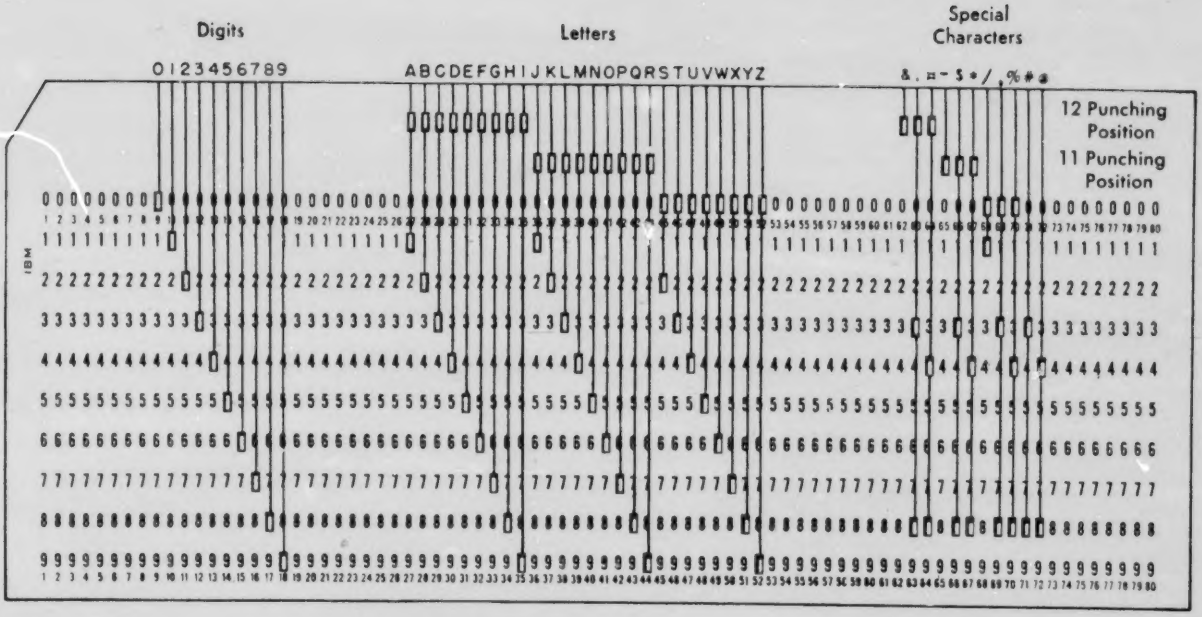

5
Move Cur. Gross Pay Final Total to Print
Move Cur. YTD Gross Pay Final Total to Print
Move Cur. FICA Final Total to Print
Move Cur. FICA YTD Final Total to Print
Move Cur. Fed. with.H. Final Total to Print
Move Cur. YTD Fed. With.H. Final Total to Print
Move Cur. State With.H. Final Total to Print
Move Cur. State YTD Final Total to Print
Move Cur. Group Ins. Final Total to Print
Move Cur. YTD Group Ins. Final Total to Print
Print
STOP

DIVISION XXXVII

FOIL #1

OVERHEAD PROJECTOR FOILS




Digits
0 1 2 3 4 5 6 7 8 9
Letters
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
Special Characters
& . ¤ - $ * / , % # @
12 Punching Position
11 Punching Position
IBM

FOIL #3

GENERAL MANUFACTURING COMPANY

ENDICOTT, N. Y.

CUSTOMER'S ORDER NO. 311 INVOICE DATE 12-31 INVOICE NO. 12349

SOLD TO New Mexico Company
216 Wysor Building
Houston, Texas

CUSTOMER NO. 59751

SHIP TO Above

Make all checks payable to

SALESMAN Macy-67

GENERAL MANUFACTURING COMPANY
Endicott, N. Y

SHIPPED VIA Truck Prepaid

TERMS 2% 10 Days Net 30

QUANTITY	COMMODITY No.	DESCRIPTION	PRICE	AMOUNT
		Casters		
40	11202	Sq. Shank Swivel	.83	33.20
75	13102	Flat Top Rigid	.84	63.00
5	17203	Ext. Shank with Brk.	1.62	8.10
2	32105	Bolt and Nut Shank	2.64	5.28
4	44104	Rnd. Spr. Ring Stem	3.51	14.04
40	62110	Bolt and Nut Shank	7.25	290.00
		Freight		.78
				414.40

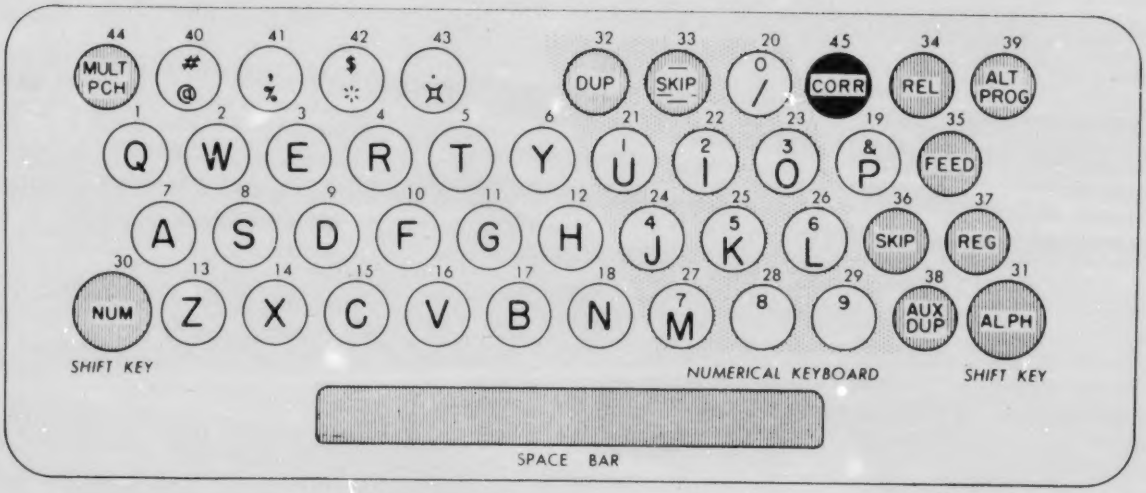
NEW MEX CO 59751411439681306712311234300040112030003320-

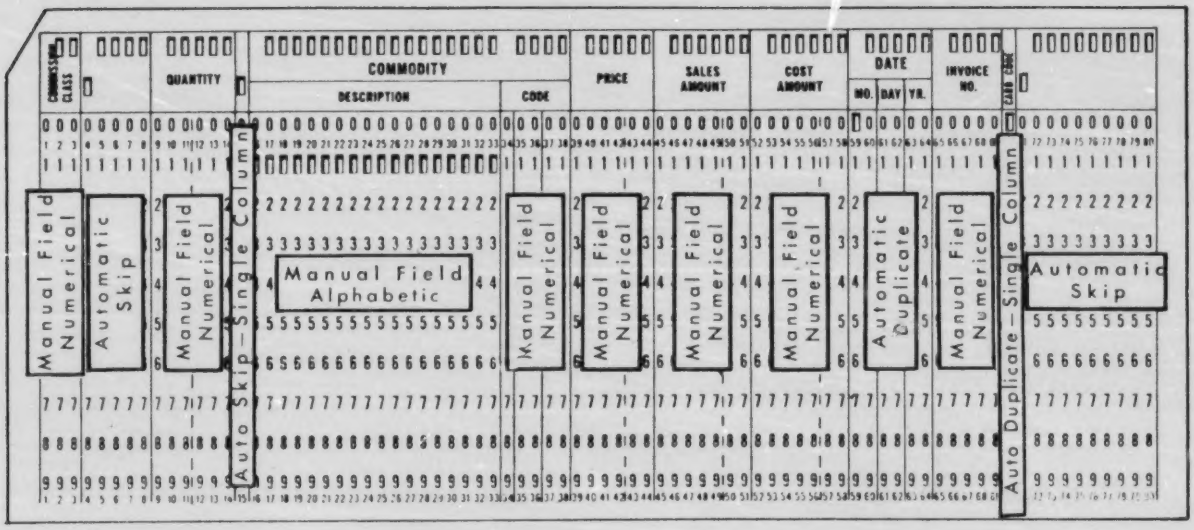
SALES ACCOUNTING

CUSTOMER NAME | CUST. NO. | LOCATION ST. CITY | TRADE CLASS | BRANCH | SALESMAN NO. | DATE MO. DAY | INV. NO. | QUANTITY | COMMODITY NO. | ITEM AMOUNT | INVOICE AMOUNT

IBM

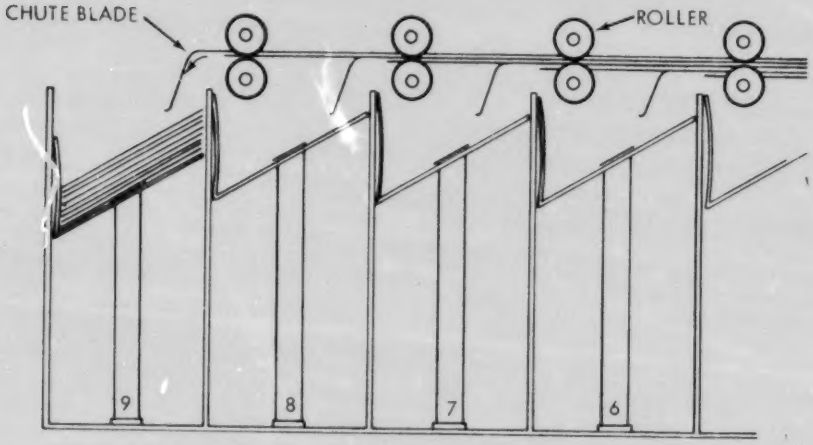
130


MULT PCH
DUP
SKIP
CORR
REL
ALT PROG
FEED
SKIP
REG
NUM
AUX DUP
ALPH
SHIFT KEY
NUMERICAL KEYBOARD
SHIFT KEY
SPACE BAR

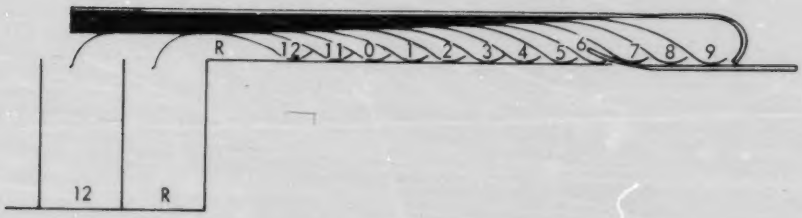


Normal Code	*Function*	*Alternate Code*
12	Field Definition	4
11	Start Auto Skip	5
0	Start Auto Duplication	6
1	Alphabetic Shift	7
2	Left Zero Print	8
3	Print Suppression	9

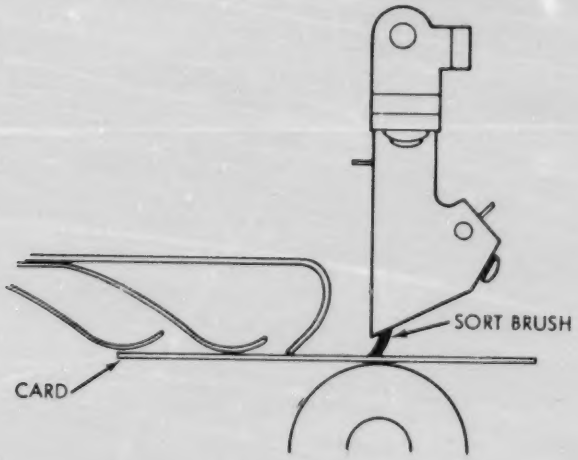
ROLLERS MOVE CARDS THROUGH CHUTES TO THE POCKETS



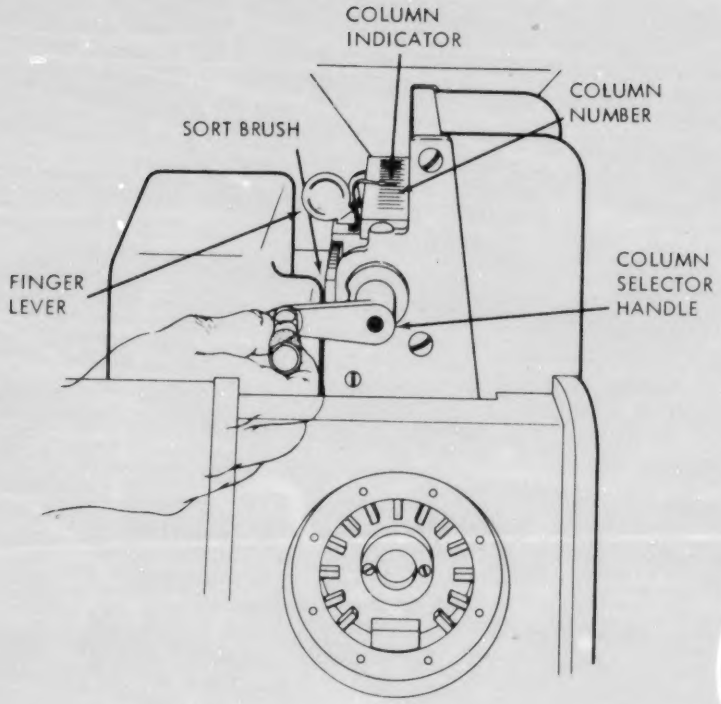
A CHUTE OPENS AS SOON AS THE PUNCH IS READ



THE SORT BRUSH READS ONE COLUMN AT A TIME



FOIL #7

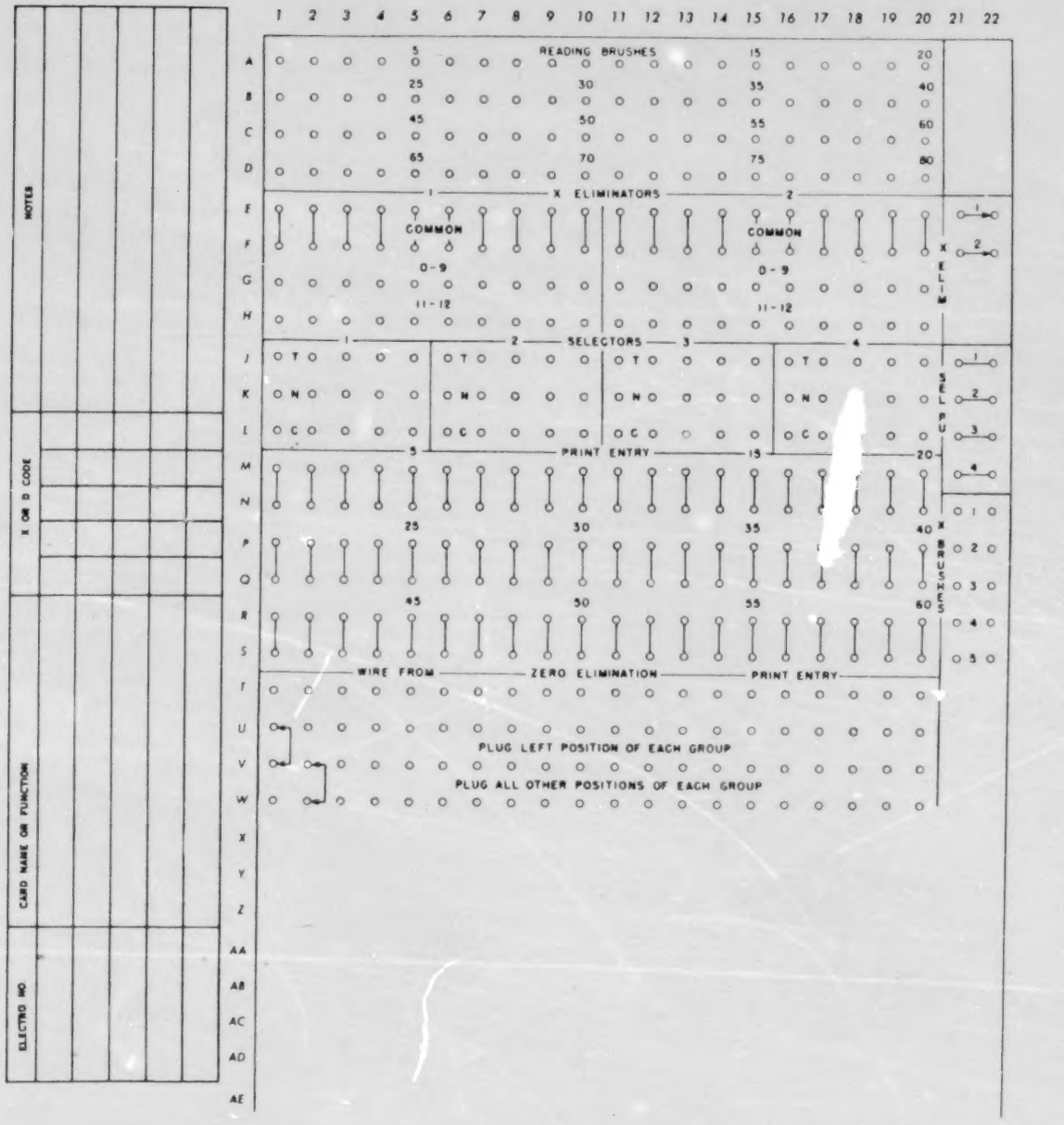

COLUMN
INDICATOR
COLUMN
NUMBER
SORT BRUSH
FINGER
LEVER
COLUMN
SELECTOR
HANDLE

IBM

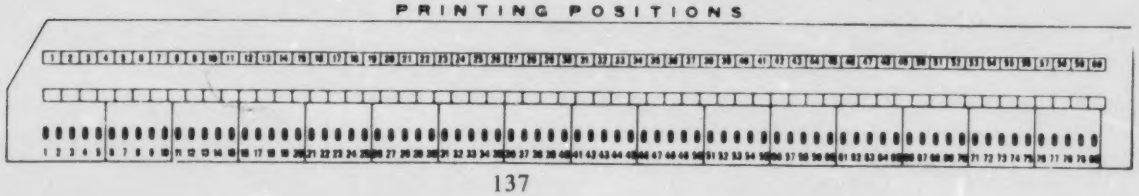
FOIL #8

IBM 548, 552 INTERPRETERS, CONTROL PANELS

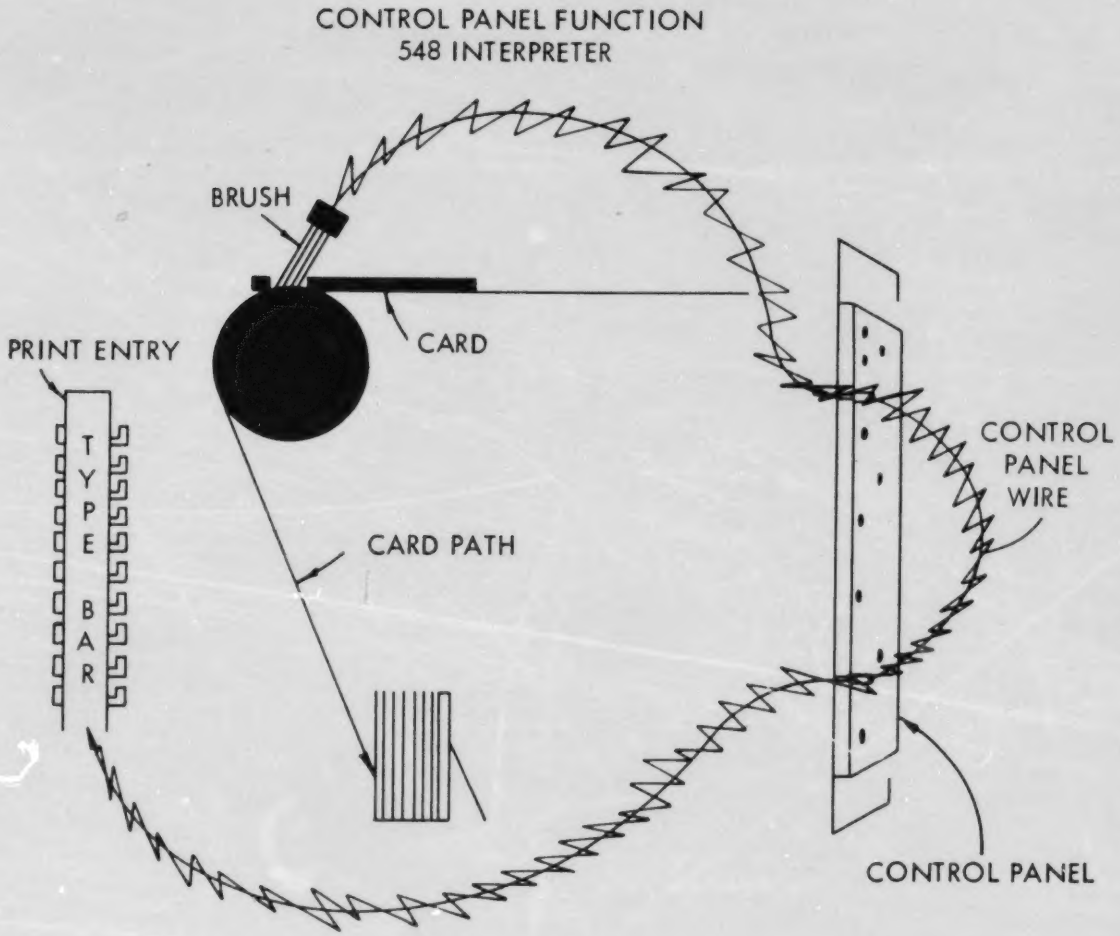
IBM 548 CONTROL PANEL



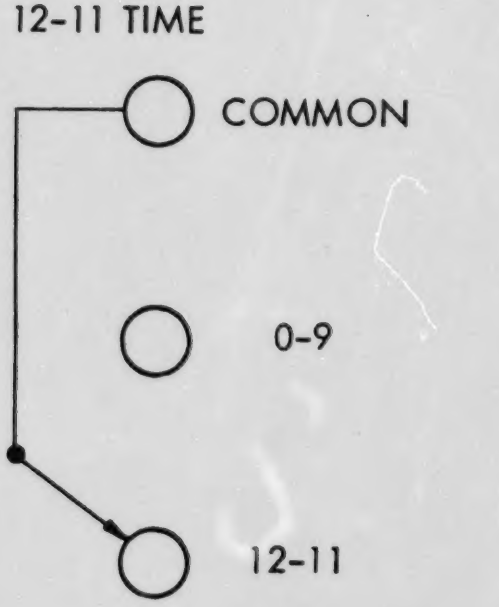
PRINTING POSITIONS

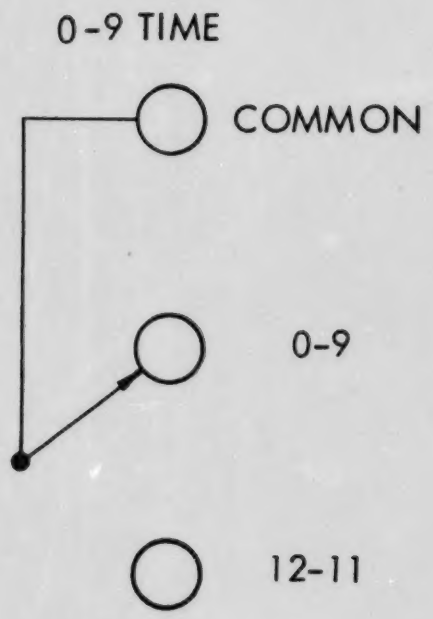


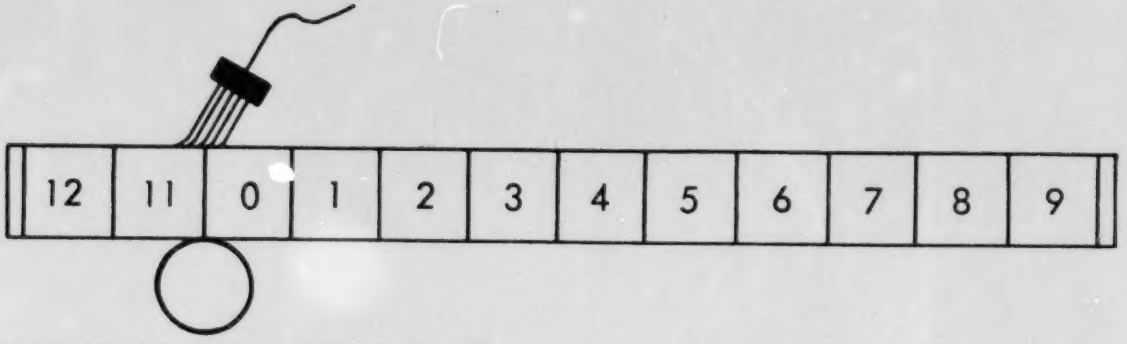
135


CONTROL PANEL FUNCTION
548 INTERPRETER
BRUSH
CARD
PRINT ENTRY
TYPE BAR
CARD PATH
CONTROL PANEL WIRE
CONTROL PANEL

X-ELIMINATOR/COLUMN SPLIT

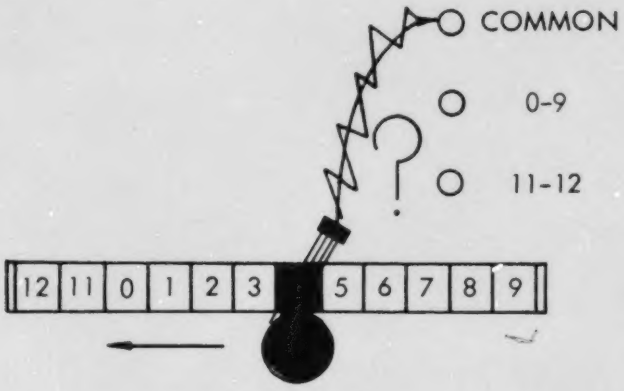




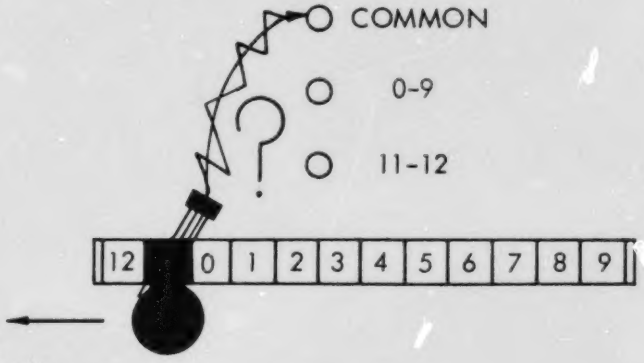


FOIL # 10

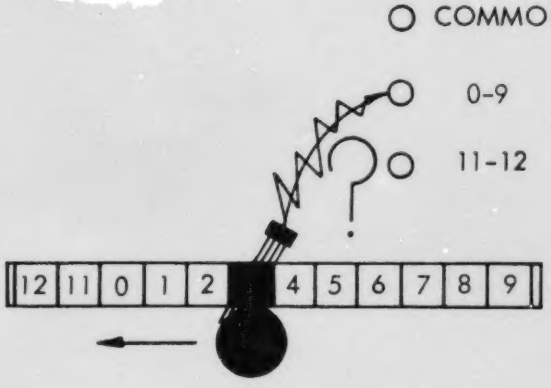
I


COMMON
0-9
11-12
12 11 0 1 2 3 5 6 7 8 9

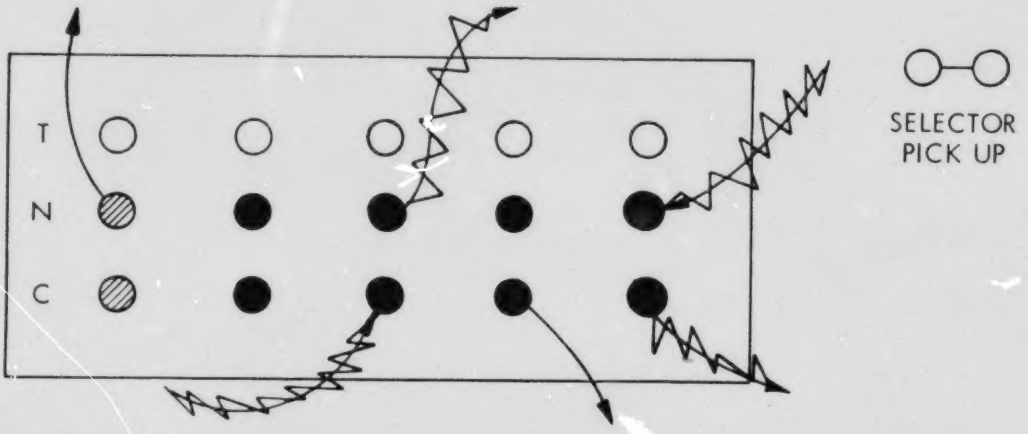
II


COMMON
0-9
11-12
12 0 1 2 3 4 5 6 7 8 9

III

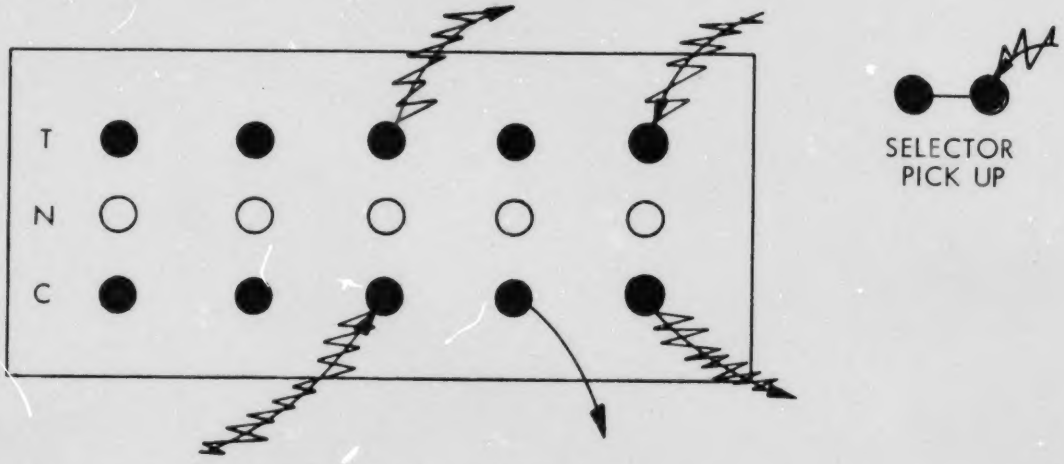

COMMON
0-9
11-12
12 11 0 1 2 4 5 6 7 8 9

148



SELECTOR (NORMAL)

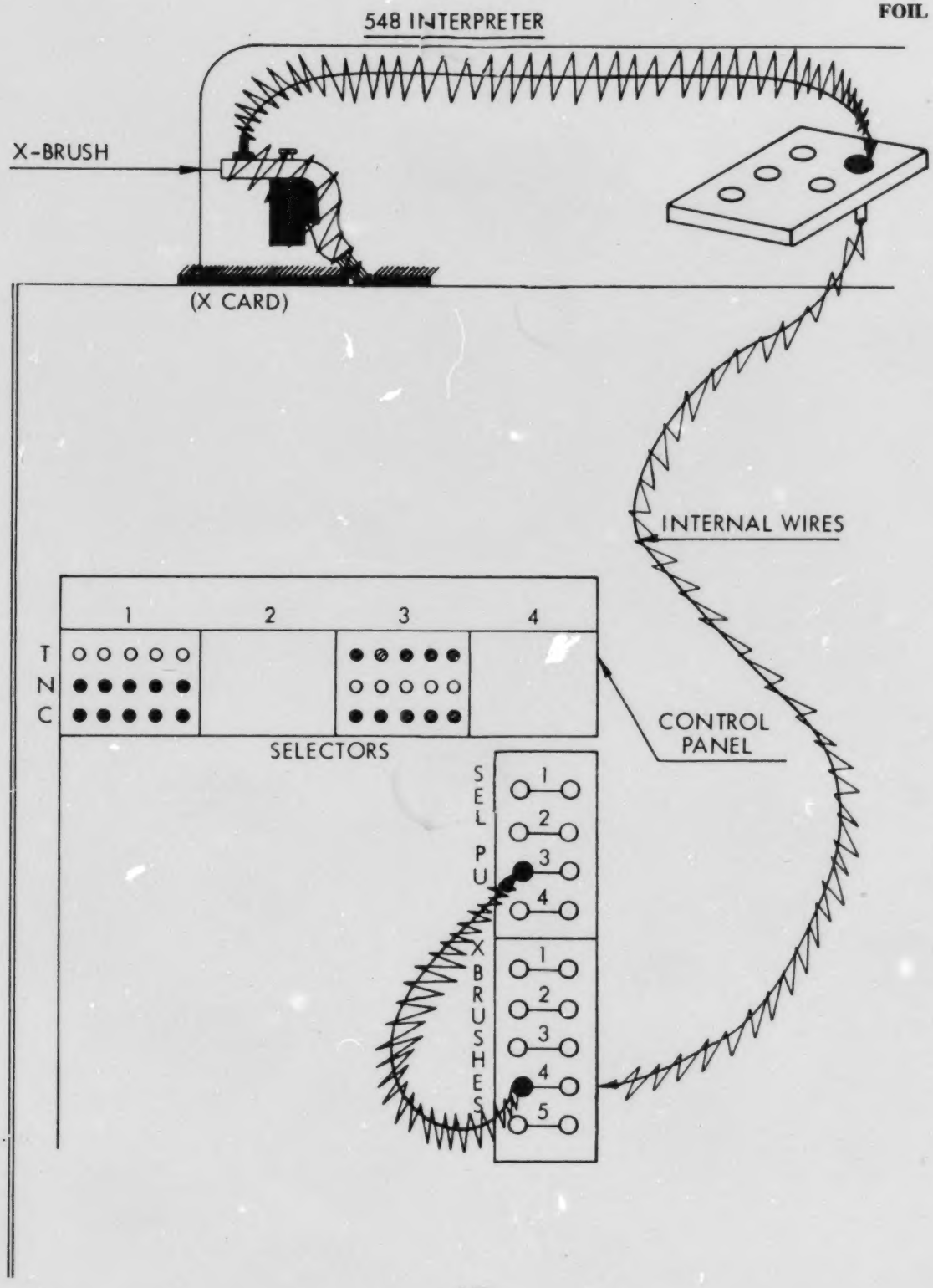
COMMON/NORMAL HUBS CONNECTED



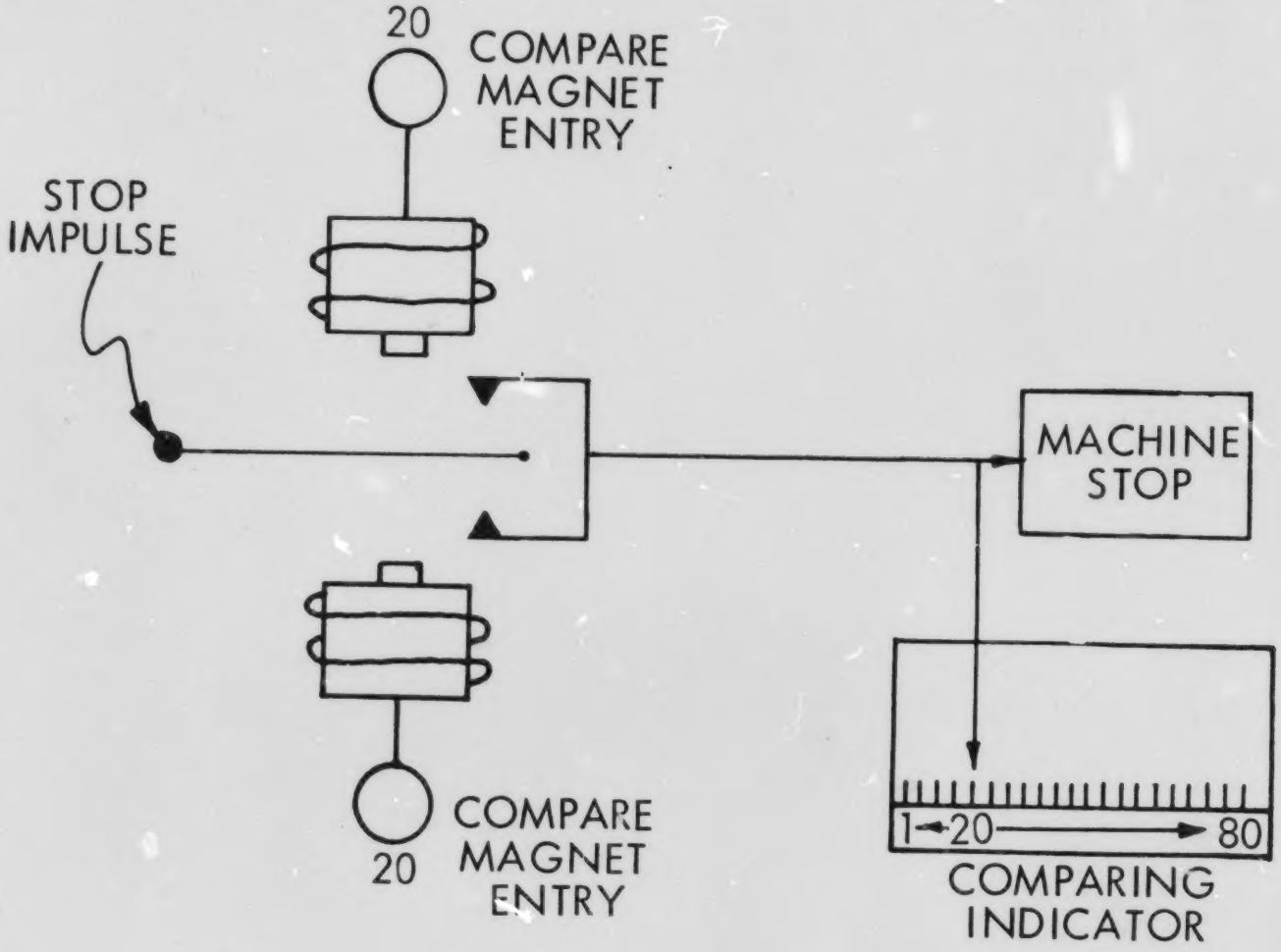
SELECTOR (TRANSFERRED)

COMMON/TRANSFERRED HUBS CONNECTED

FOIL #13

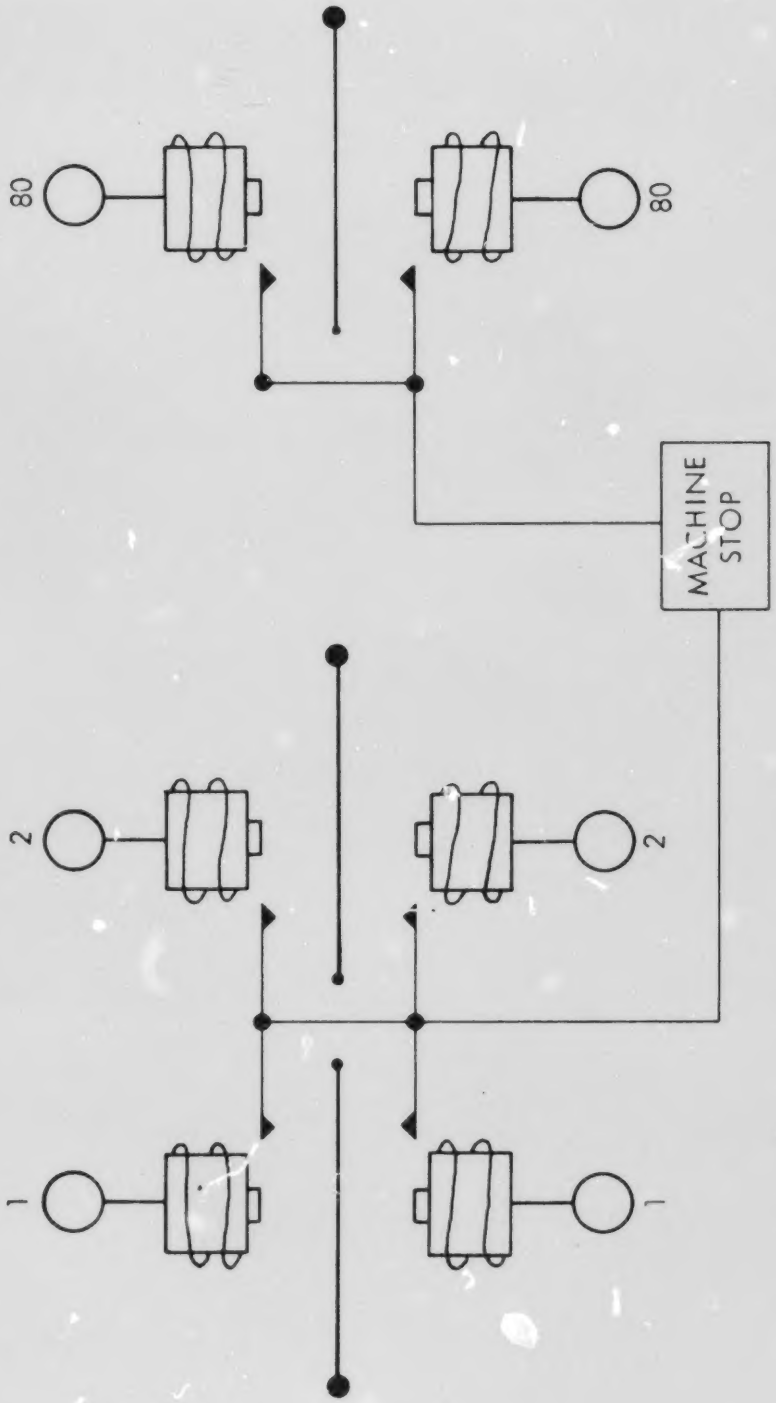

548 INTERPRETER
X-BRUSH
(X CARD)
INTERNAL WIRES
1
2
3
4
T
N
C
SELECTORS
CONTROL PANEL
SEL PU
X BRUSHES
1
2
3
4
1
2
3
4
5

COMPARING UNIT



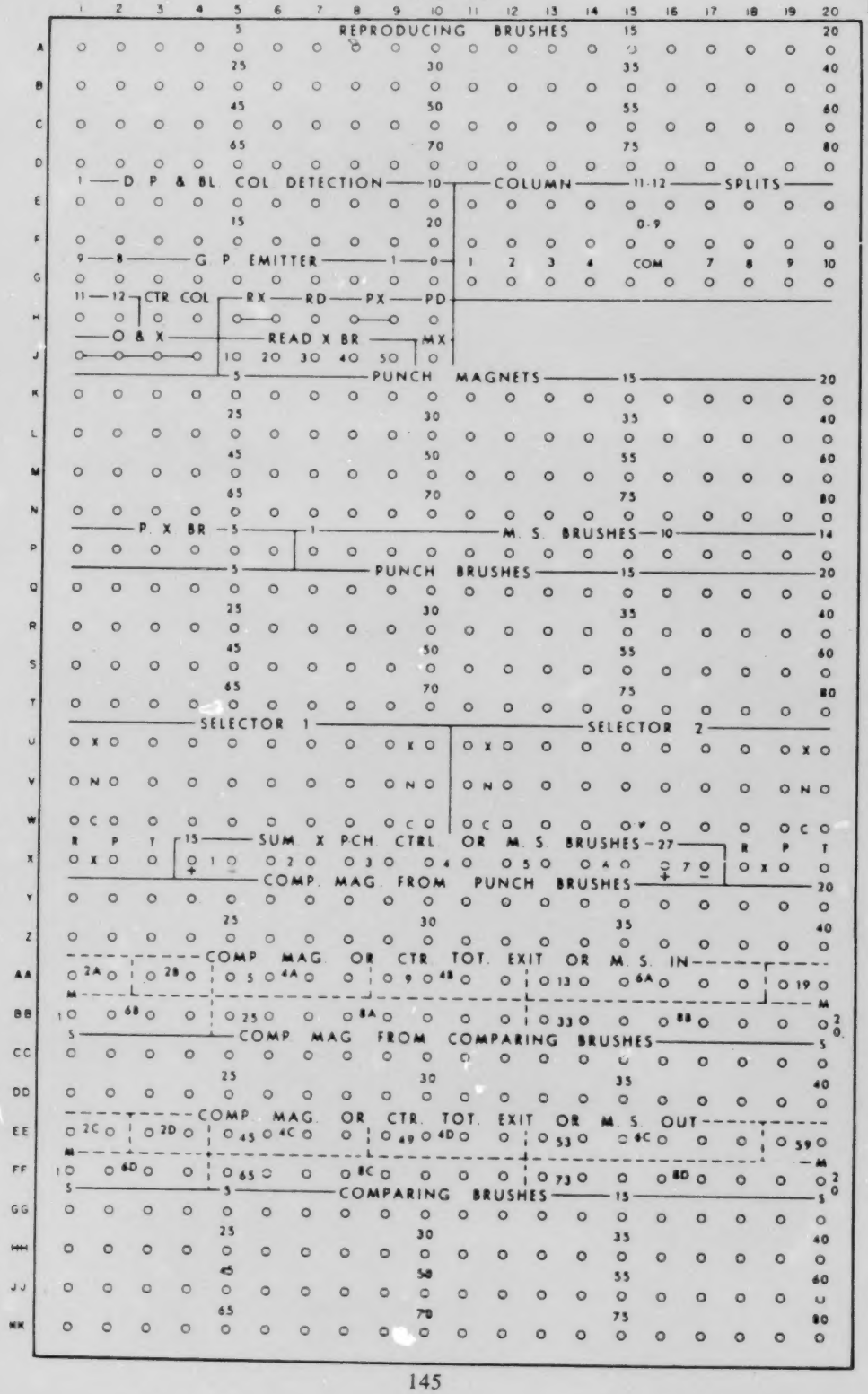
FOIL #14

514 COMPARING UNIT



513-514

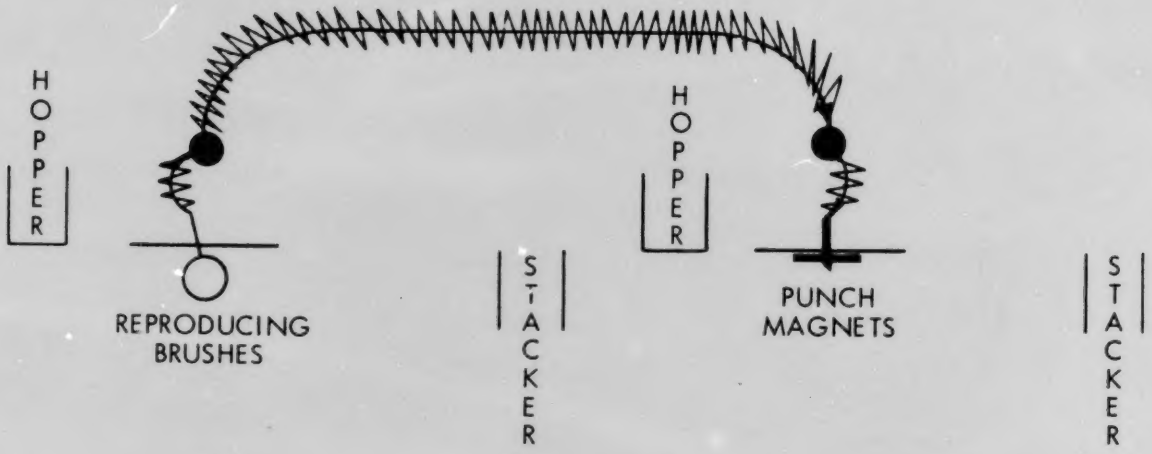
FOIL #16



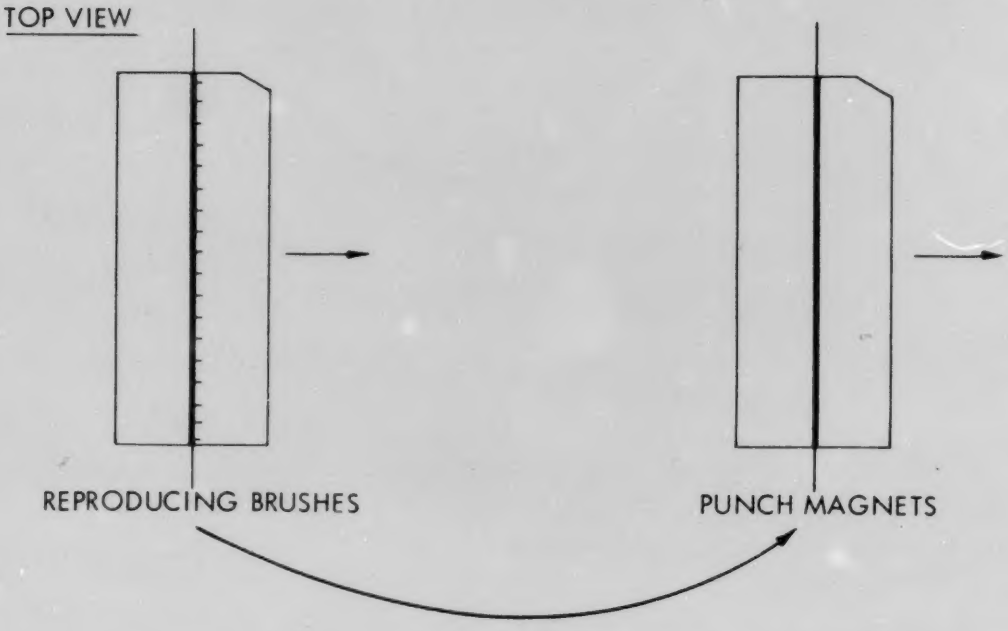
A5.3

514 REPRODUCER SCHEMATIC

SIDE VIEW



TOP VIEW

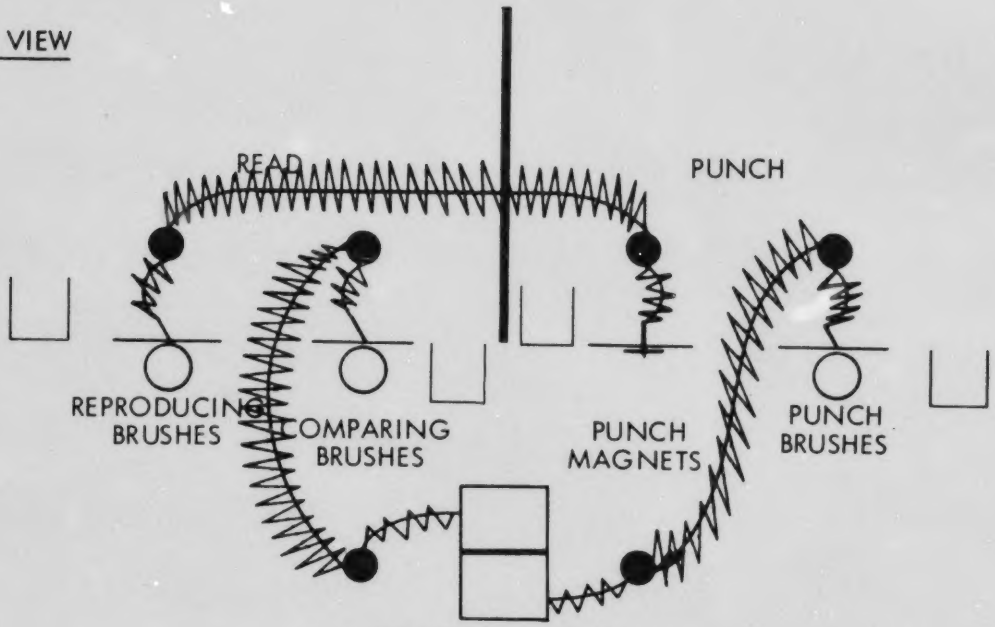


154

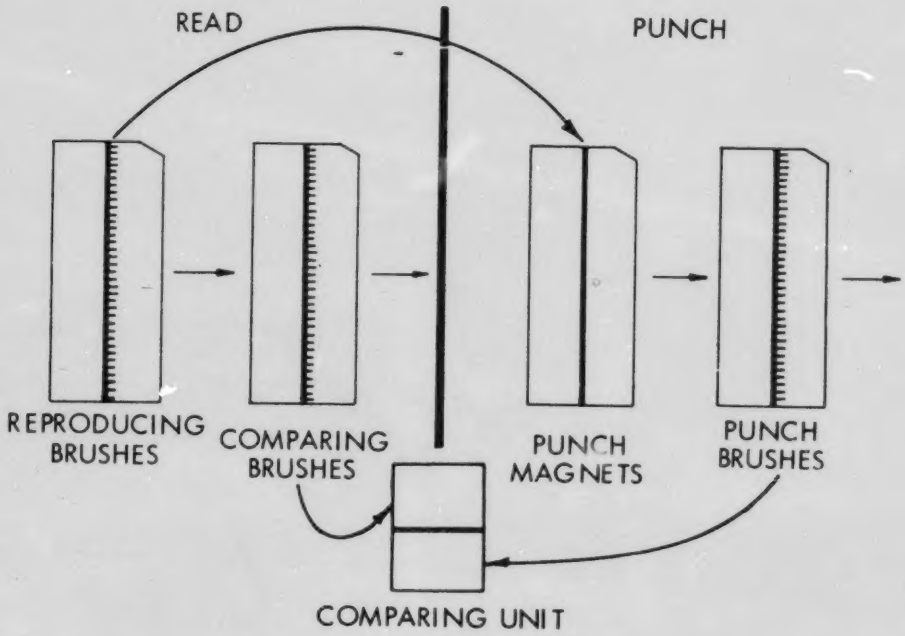
514 REPRODUCER SCHEMATIC

FOIL #18

SIDE VIEW

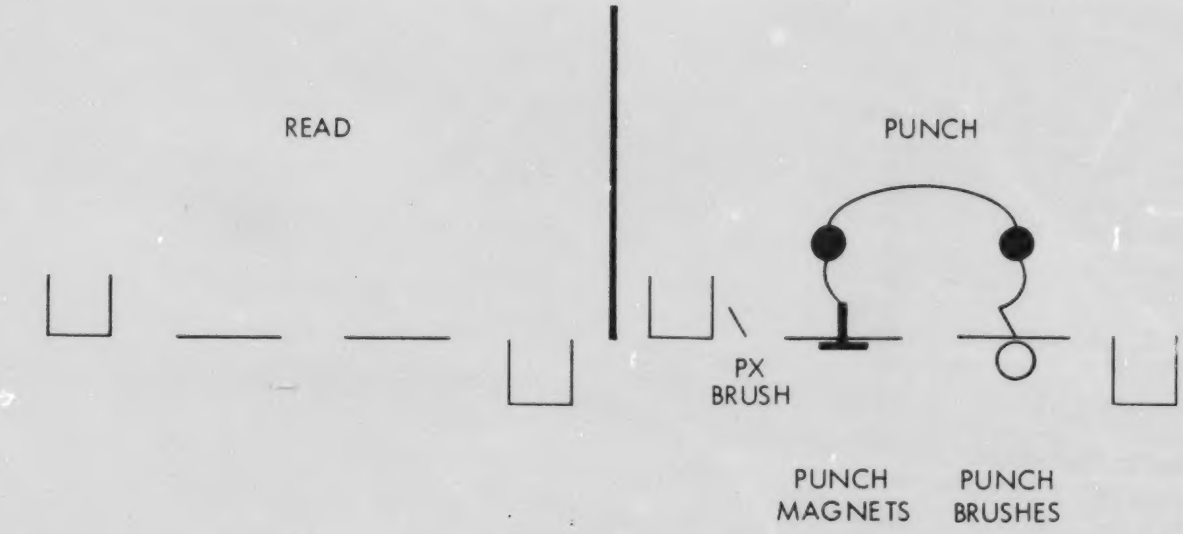


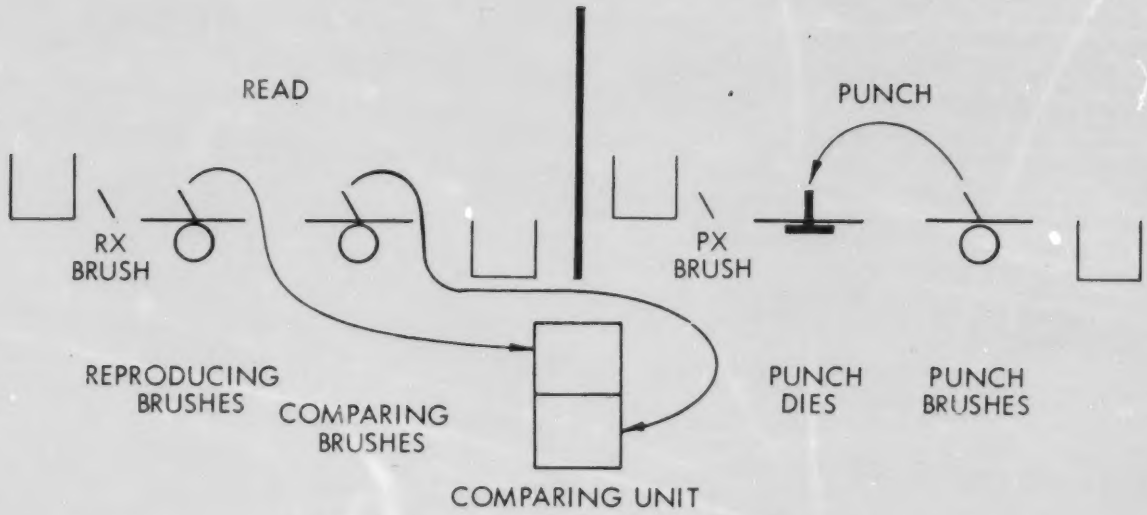
TOP VIEW



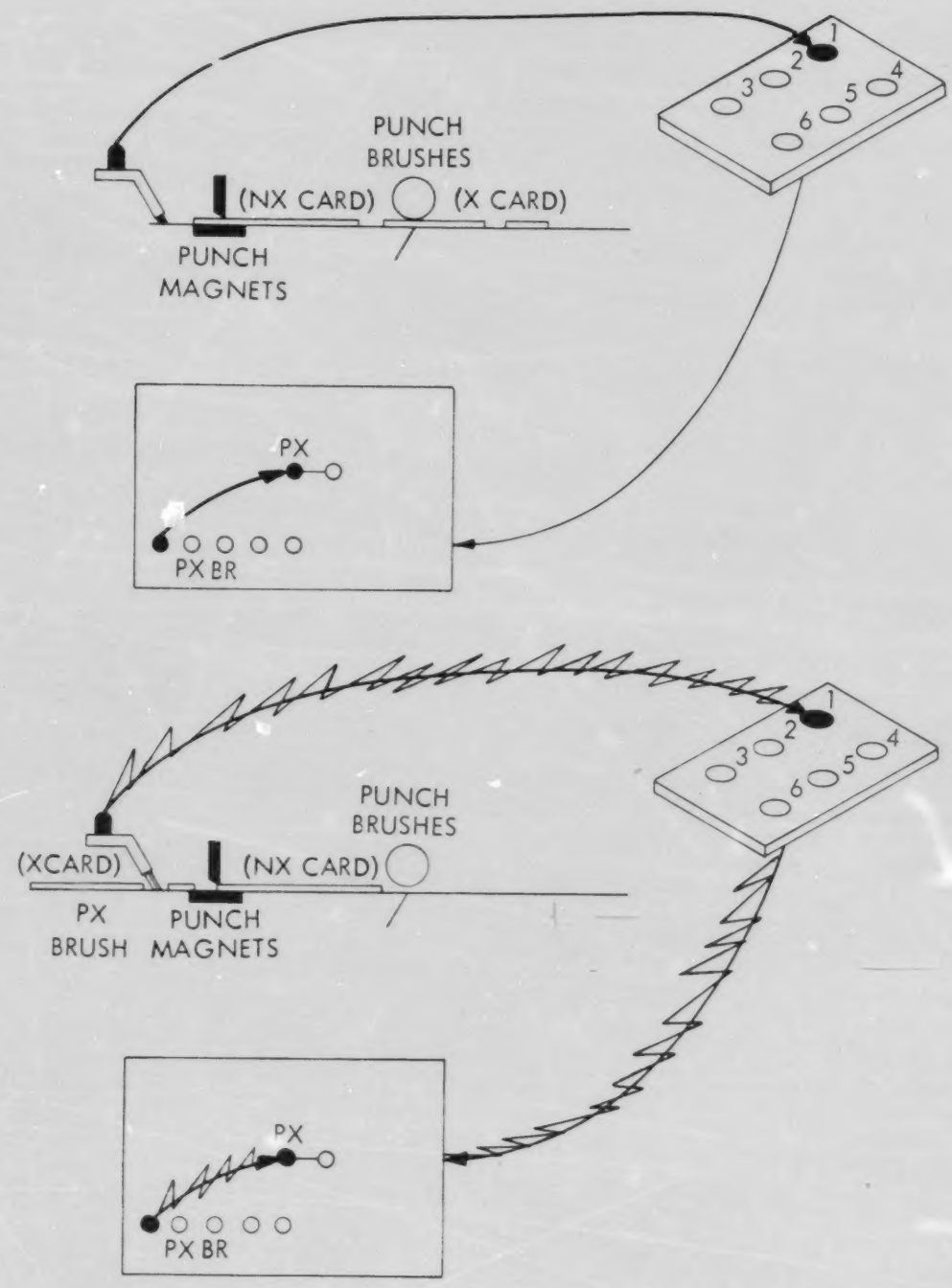
455

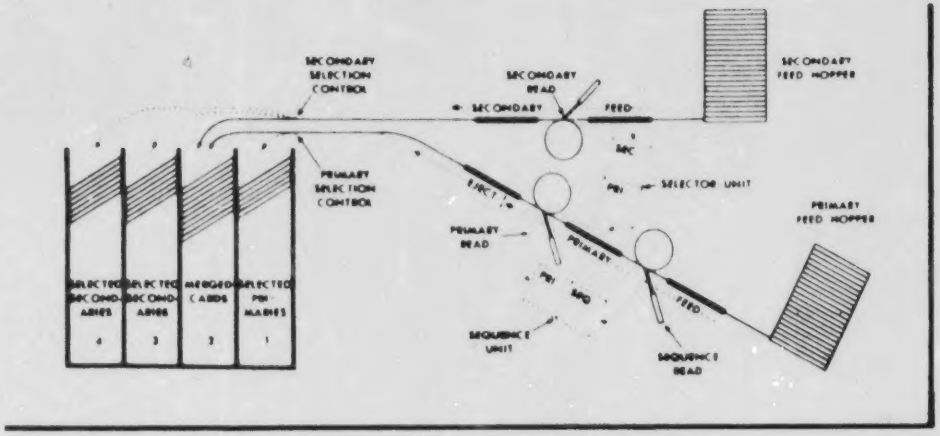
GANG PUNCHING AND COMPARING

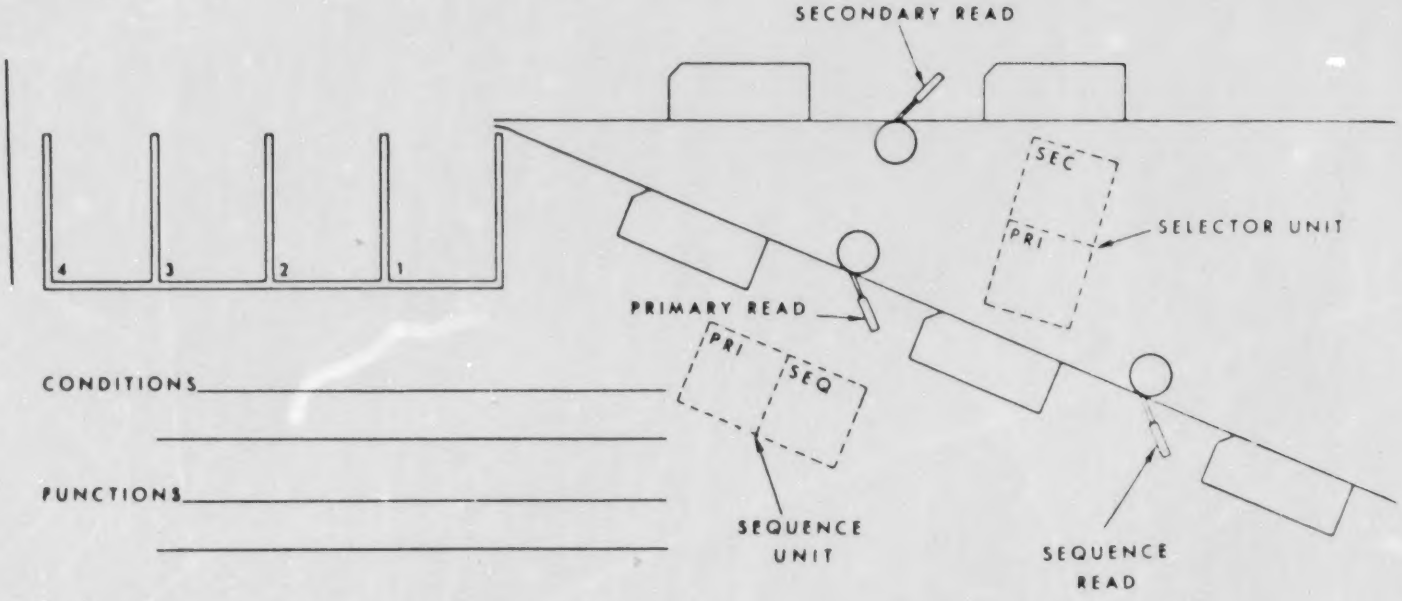




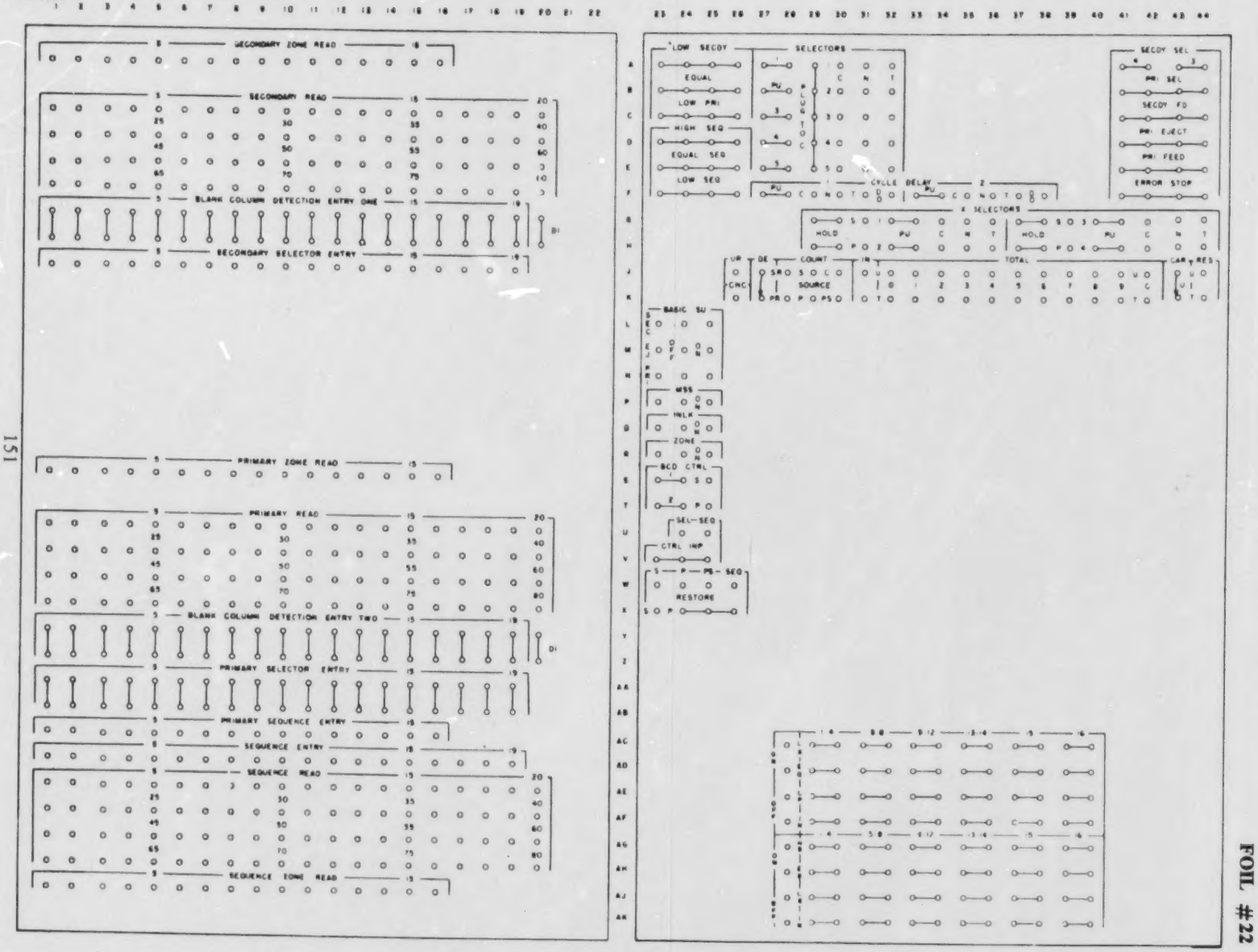
PX FUNCTION


1
2
3
4
5
6
PUNCH
BRUSHES
(NX CARD)
(X CARD)
PUNCH
MAGNETS
PX
PX BR
1
2
3
4
5
6
PUNCH
BRUSHES
(XCARD)
(NX CARD)
PX
BRUSH
PUNCH
MAGNETS
PX
PX BR


SECONDARY SELECTION CONTROL
SECONDARY READ
SECONDARY
FEED
SECONDARY FEED HOPPER
PRIMARY SELECTION CONTROL
SELECTOR UNIT
PRIMARY FEED HOPPER
PRIMARY READ
PRIMARY
FEED
SEQUENCE UNIT
SEQUENCE READ


SECONDARY READ
SEC
PRI
SELECTOR UNIT
4
3
2
1
PRIMARY READ
PRI
SEQ
CONDITIONS
FUNCTIONS
SEQUENCE UNIT
SEQUENCE READ

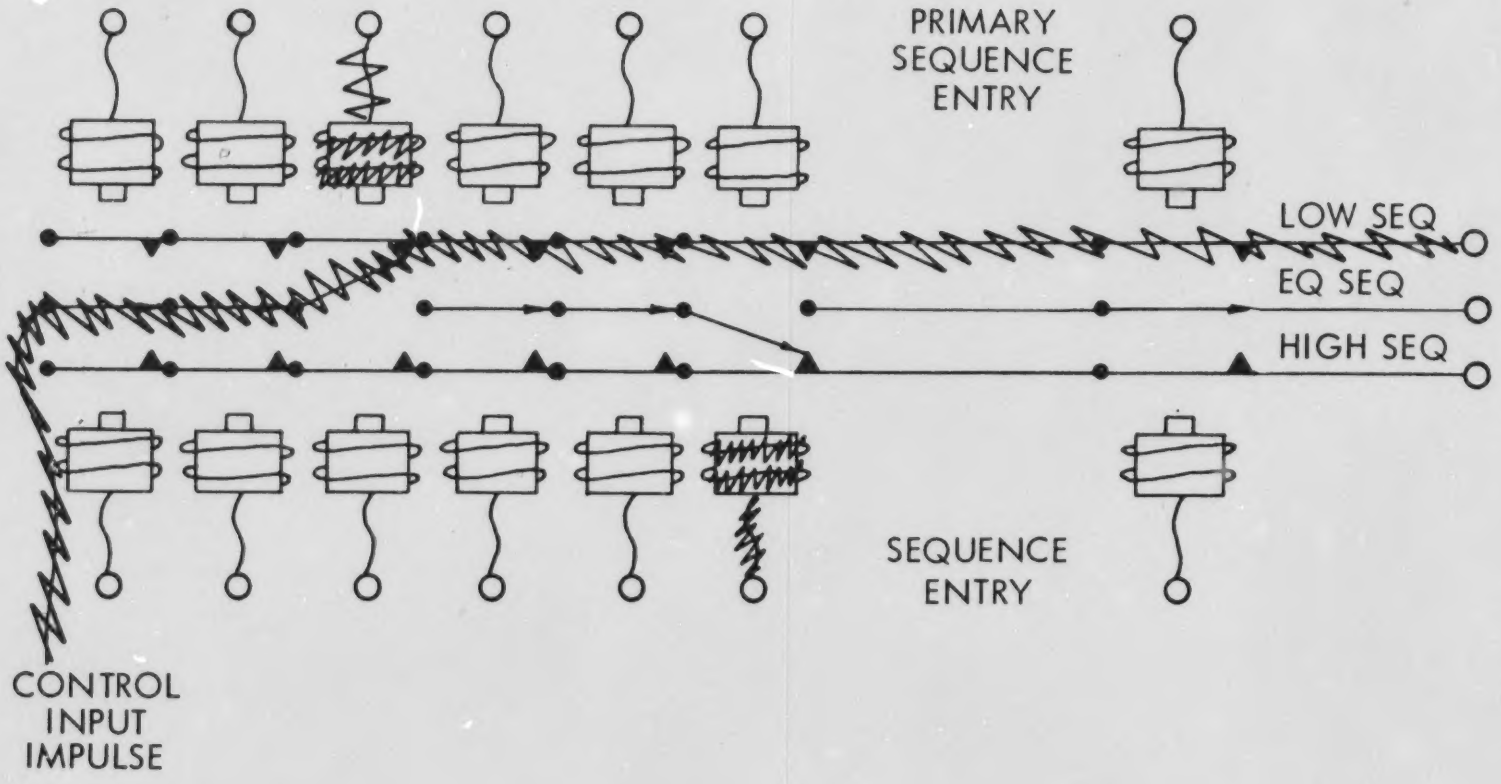
FOIL #21



151

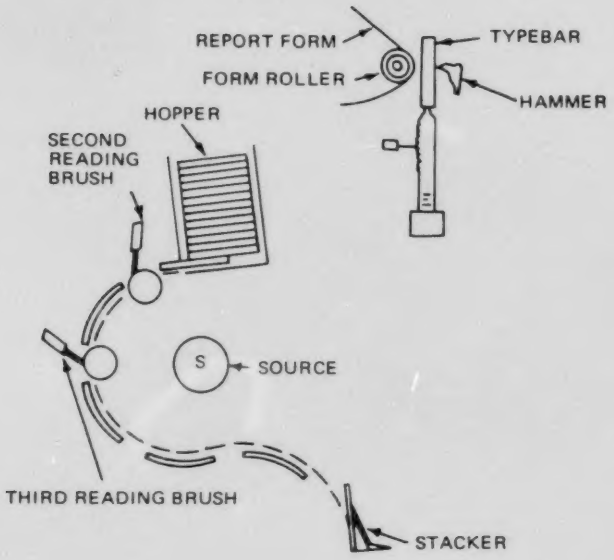
159

FOIL #22

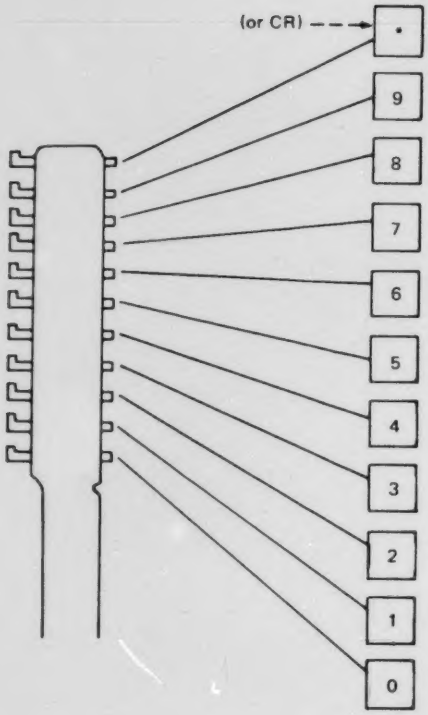


COLLATOR COMPARING UNIT

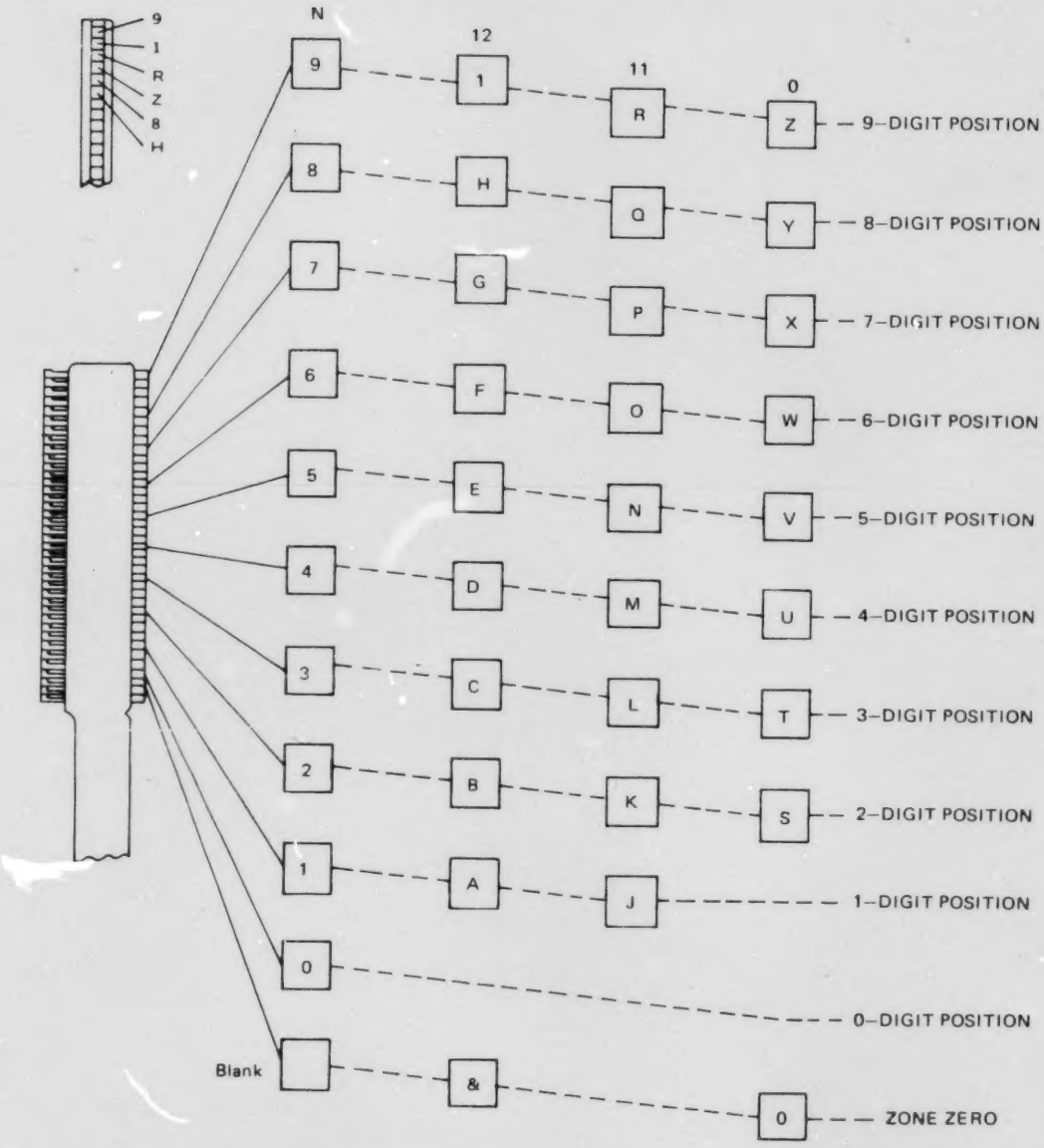
FOIL #23



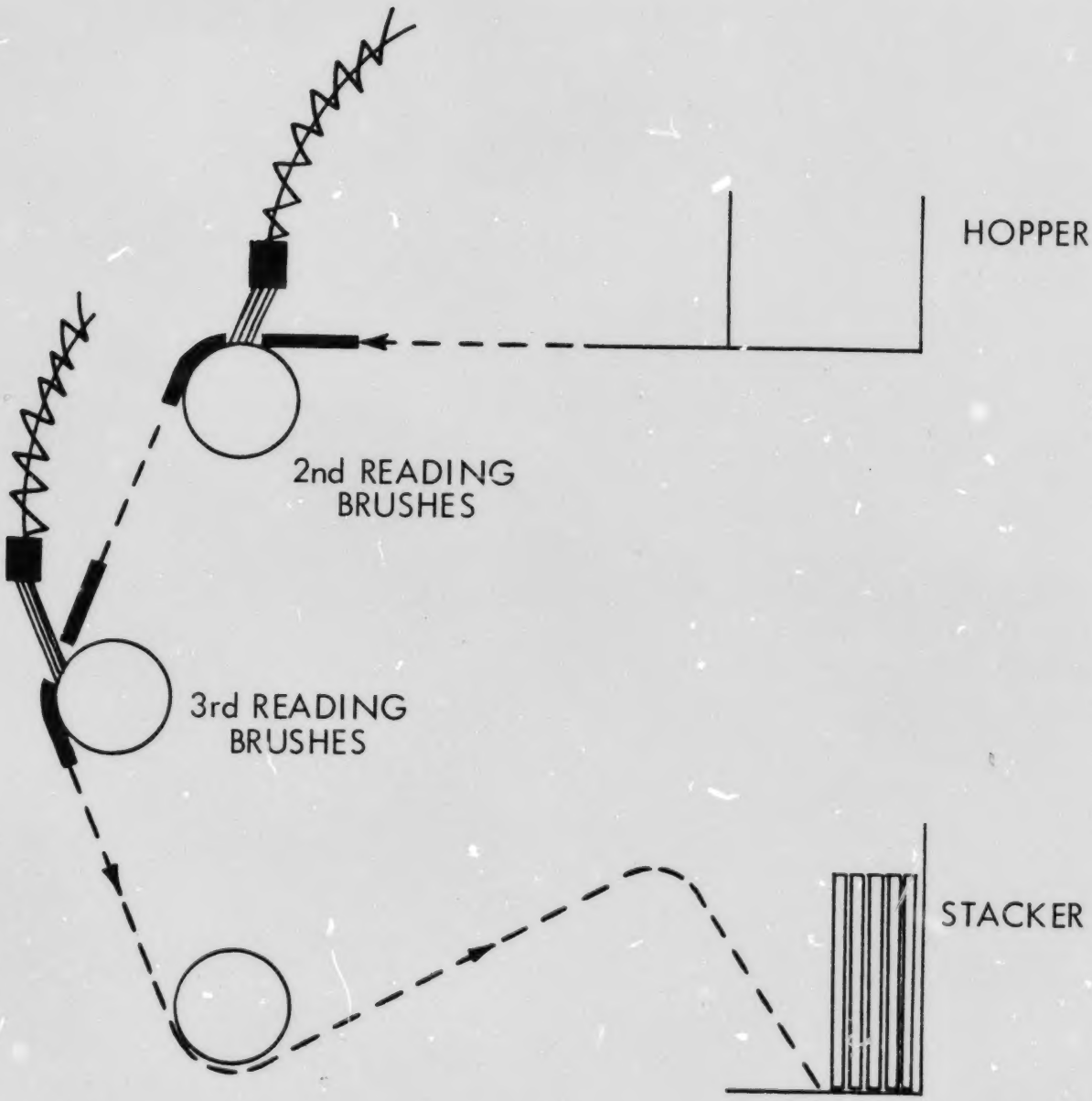
FEED UNIT AND PRINT UNIT



NUMERICAL TYPE BAR



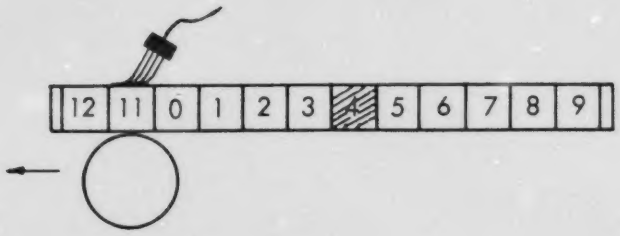
ALPHAMERIC TYPE BAR



402 ACCOUNTING MACHINE
READ SCHEMATIC

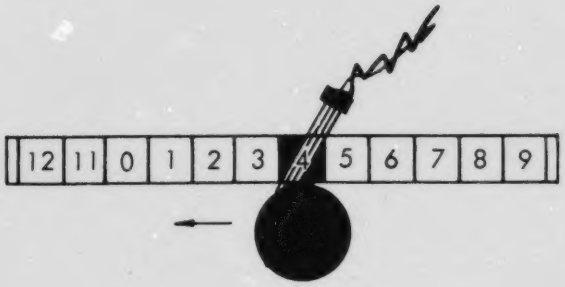
CARD READING

I



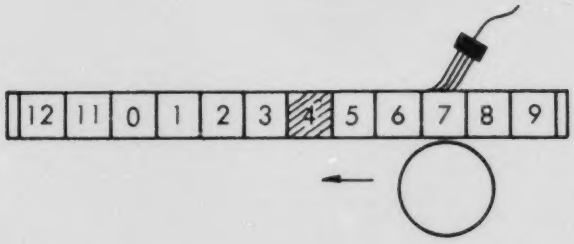
CARD INSULATING BRUSH FROM ELECTRICALLY CHARGED ROLLER

II



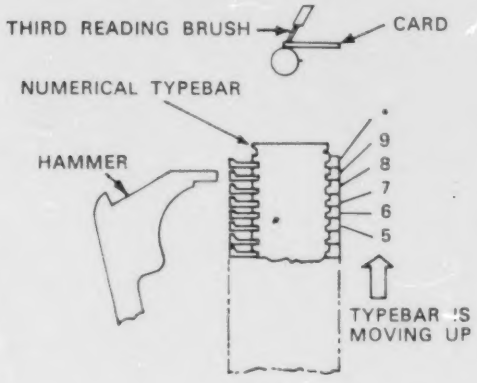
BRUSH CONTACTS ELECTRICALLY CHARGED ROLLER

III



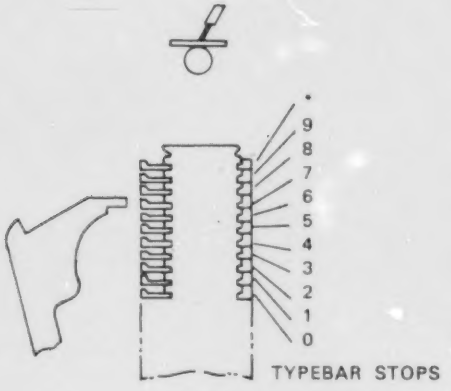
CARD INSULATES BRUSH FROM ROLLER

CARD HAS JUST ENTERED THE THIRD READING BRUSHES AND IS BEING READ IN THE 9TH ROW.



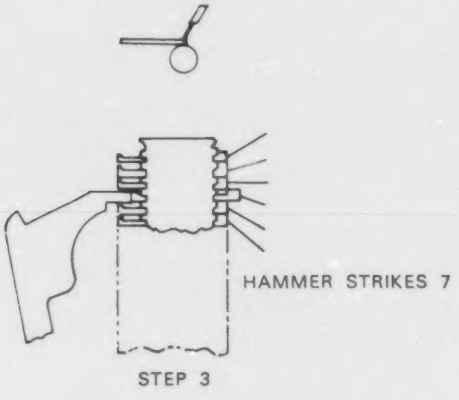
STEP 1

CARD IS NOW BEING READ IN THE 7TH ROW AND A PUNCH IS DETECTED



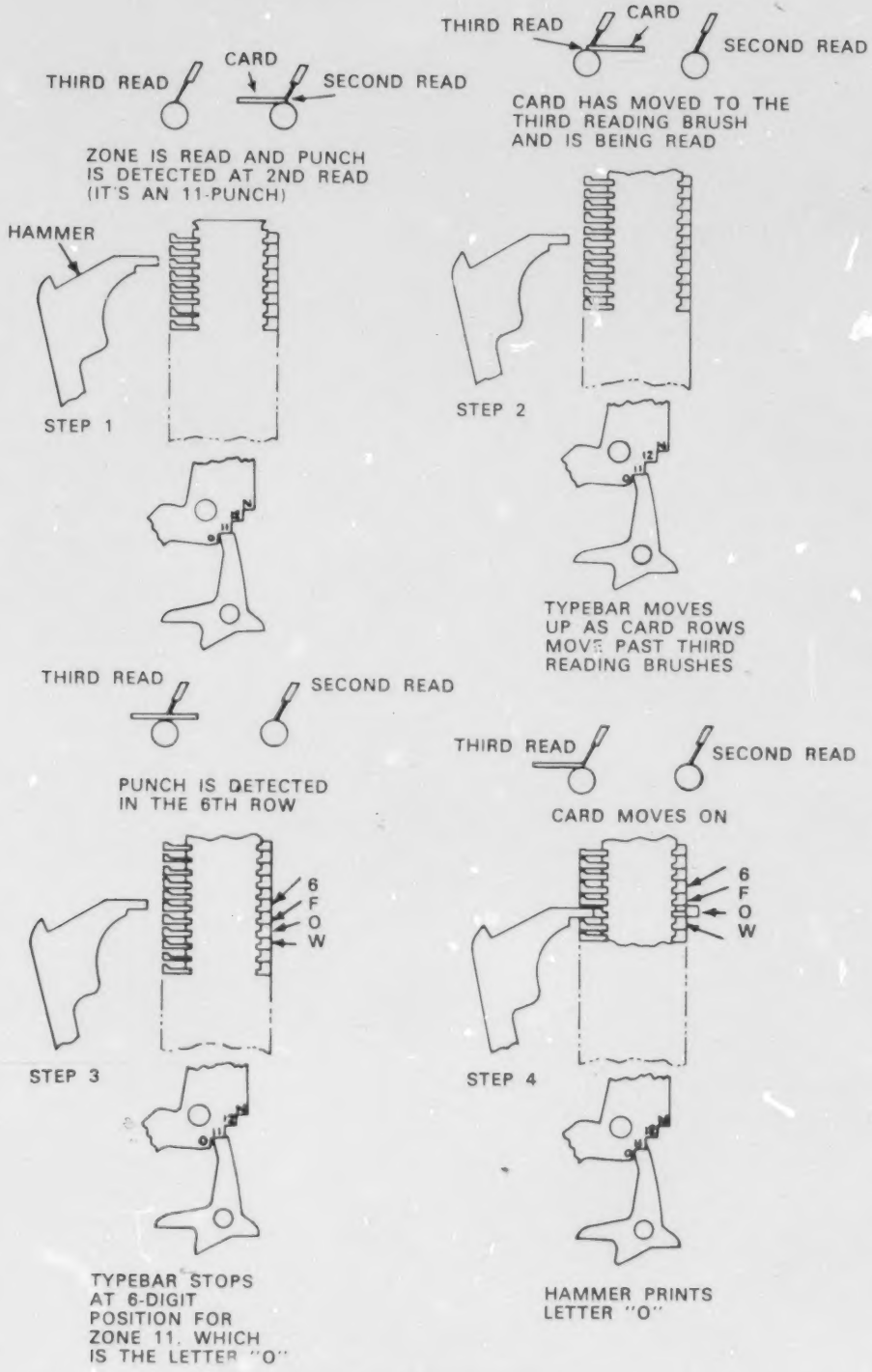
STEP 2

CARD MOVES ON



STEP 3

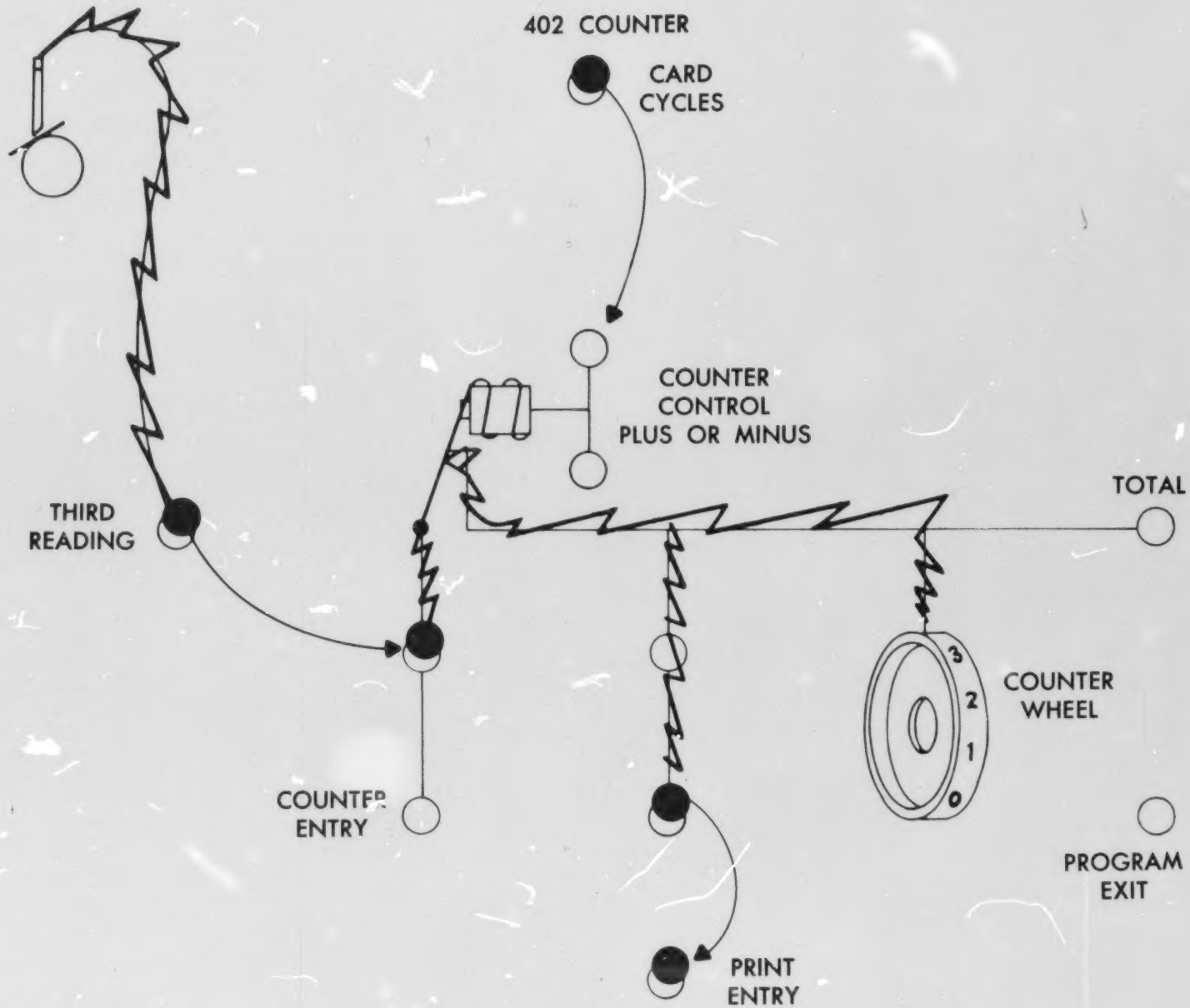
NUMERICAL TYPEBAR OPERATION



ALPHAMERIC TYPEBAR OPERATION

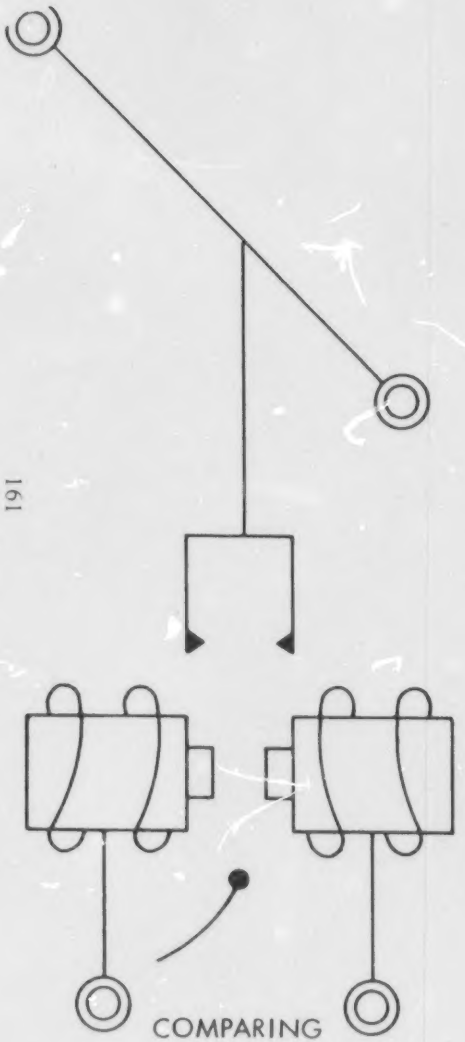
FOIL #30

COUNTER WHEELS

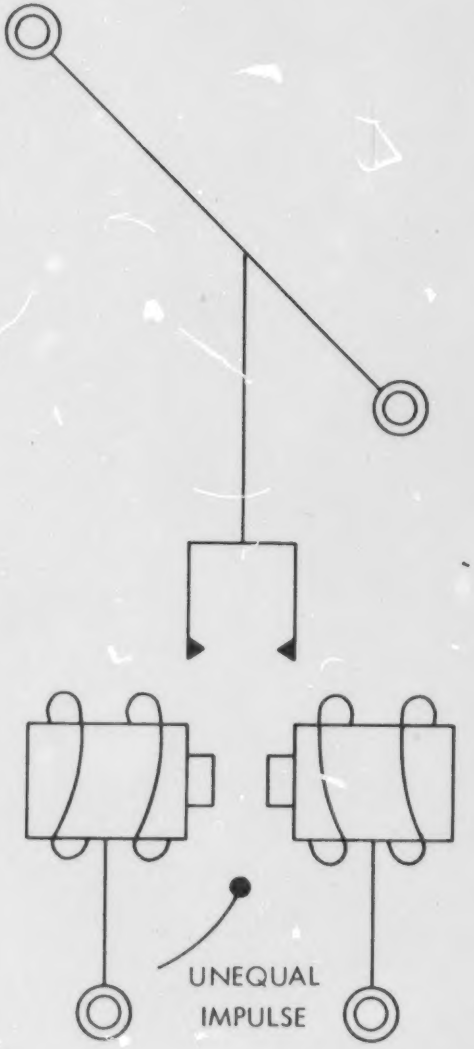

402 COUNTER
CARD CYCLES
COUNTER CONTROL PLUS OR MINUS
TOTAL
THIRD READING
COUNTER WHEEL
3
2
1
0
COUNTER ENTRY
PROGRAM EXIT
PRINT ENTRY

FOIL #31

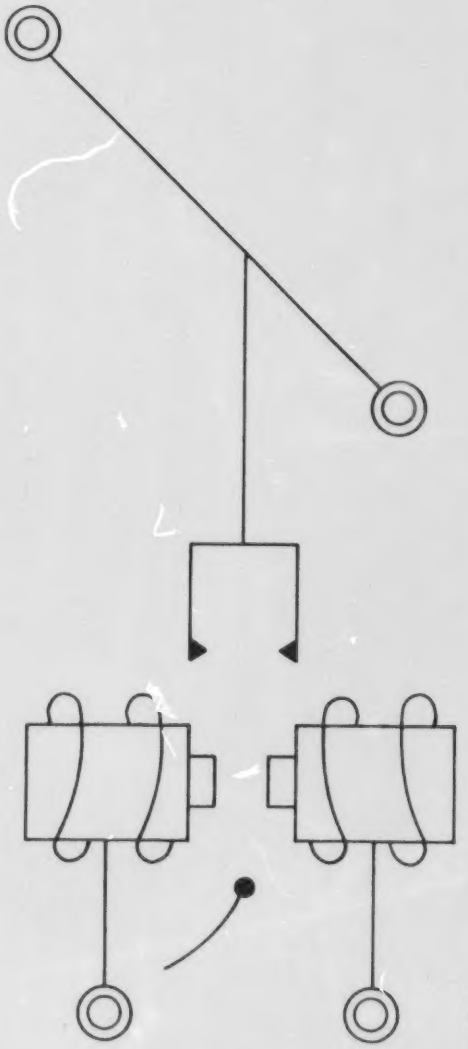
ACCOUNTING MACHINE COMPARING



COMPARING ENTRIES

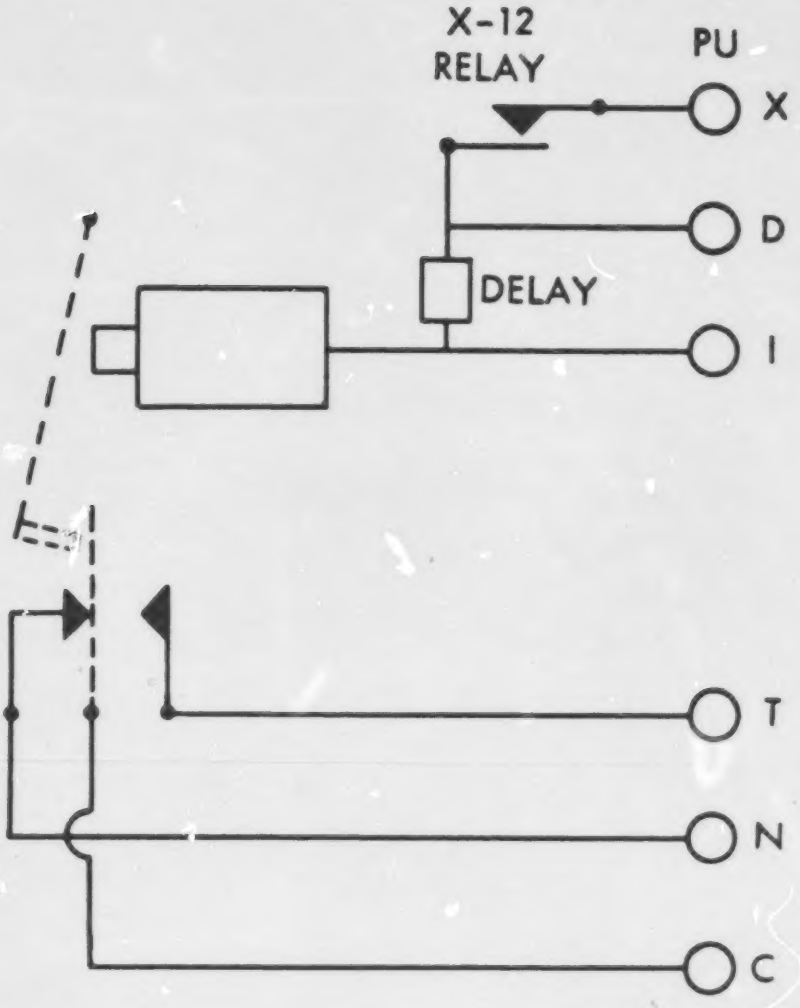


UNEQUAL IMPULSE

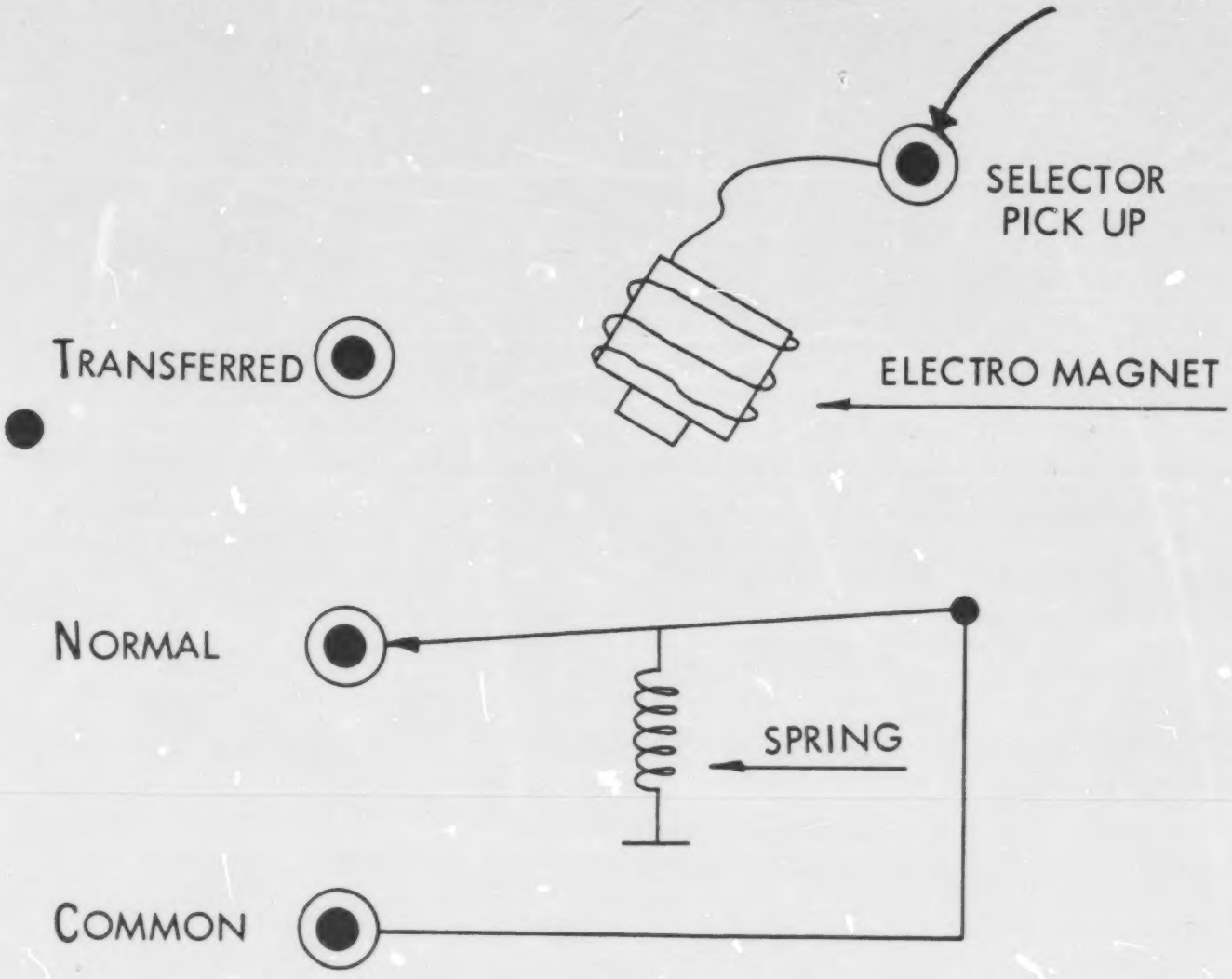


FOIL #32

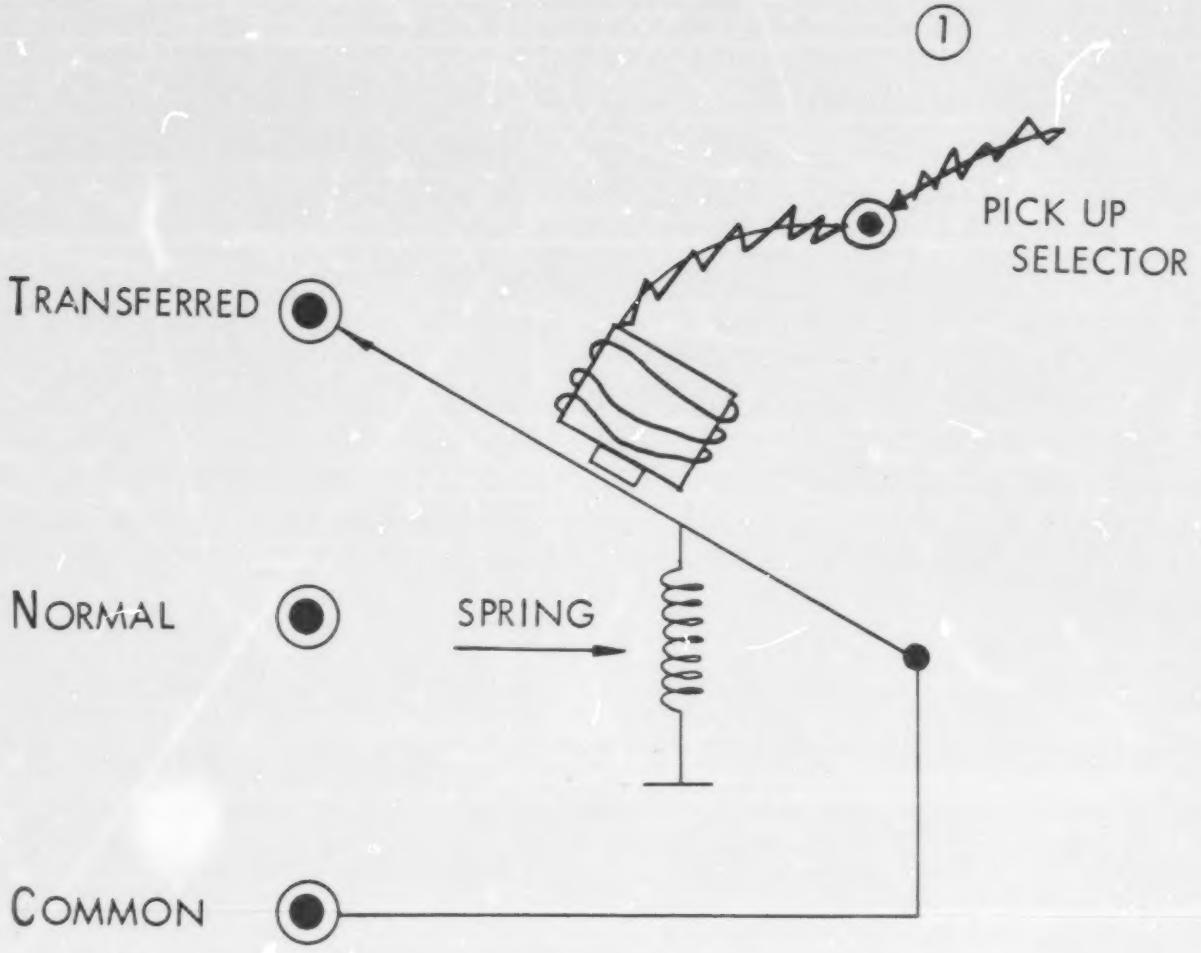
SELECTOR SCHEMATIC WITH 3 PICKUPS



SELECTOR SCHEMATIC
NORMAL CONDITION

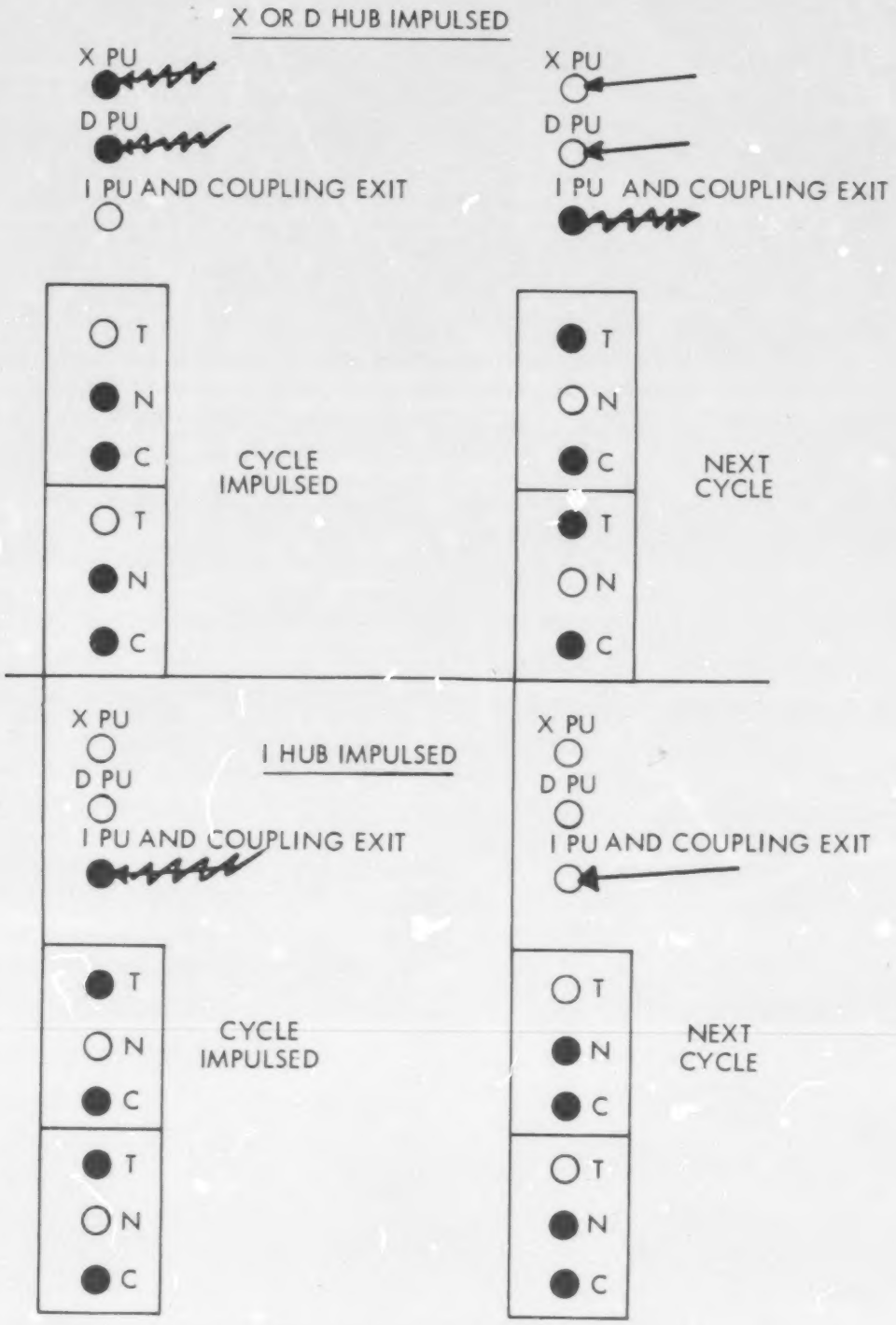


SELECTOR SCHEMATIC
TRANSFERRED CONDITION

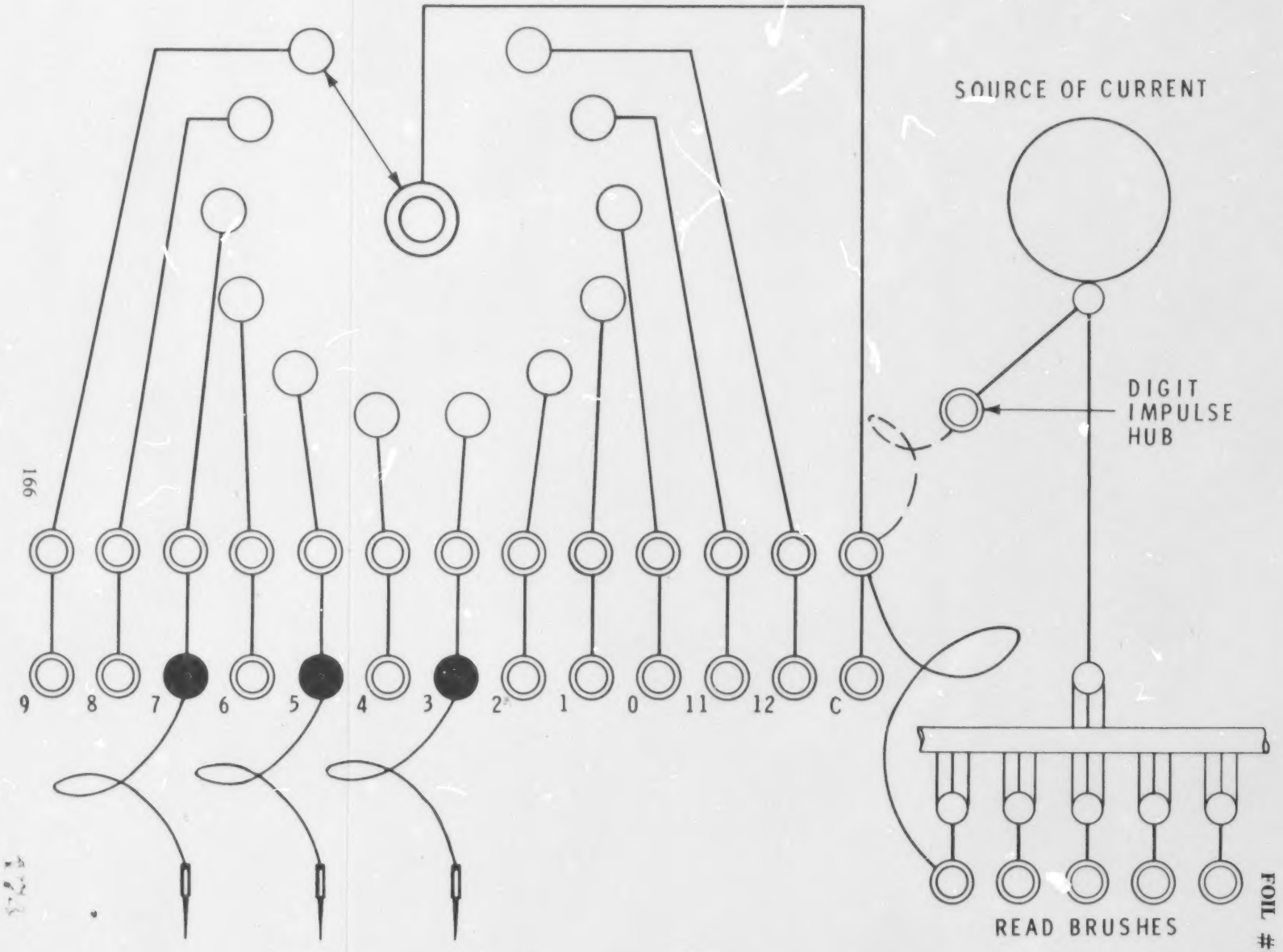


NOTE:

IMPULSE (1) ONLY ACTIVATES ELECTROMAGNET
IT DOES NOT HAVE A PATH TO THE TRANSFERRED
OR COMMON HUB.



402 SELECTOR OPERATION

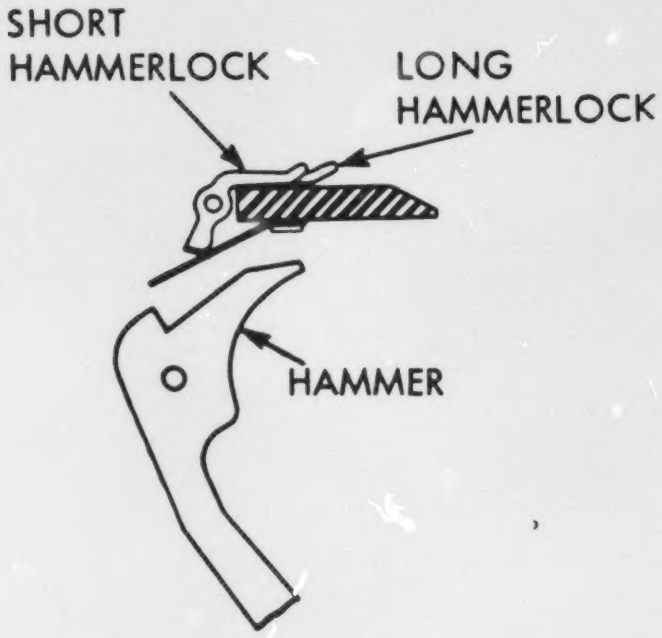

SOURCE OF CURRENT
DIGIT
IMPULSE
HUB
166
9
8
7
6
5
4
3
2
1
0
11
12
C
READ BRUSHES

FOIL #37

PICK UP	ACCEPTS	TRANSFERS	DROPS OUT
X-PU	11-12	BEGINNING OF NEXT CYCLE	END OF NEXT CYCLE
D-PU	9-12	BEGINNING OF NEXT CYCLE	END OF NEXT CYCLE
I-PU	9-12	IMMEDIATELY	END OF SAME CYCLE

PILOT SELECTOR OPERATION

FOIL #38



HAMMERLOCKS IN
NORMAL POSITION

SHORT HAMMERLOCK RAISED

LONG HAMMERLOCK RAISED

LONG HAMMERLOCK RAISED

FOIL #40

EXPENSE DISTRIBUTION
BY DEPARTMENT OR BRANCH

DEPT. OR BRANCH	ACCOUNT No. GEN. LEDG.	ACCOUNT No. SUB LEDG.	OUR INVOICE NUMBER	DATE MO.	DATE DAY	AMOUNT	AMOUNT BY ACCOUNT	AMOUNT BY DEPT. OR BRANCH
82	431	112	12066	12	10	30000		
82	431	112	12153	12	28	30000		
						60000*		
82	431	113	12066	12	10	15000		
82	431	113	12066	12	10	15000		
82	431	113	12066	12	10	12500		
82	431	113	12153	12	28	15000		
82	431	113	12153	12	28	15000		
82	431	113	12153	12	28	12500		
						85000*		
82	431	114	12066	12	10	5000		
82	431	114	12066	12	10	7500		
82	431	114	12066	12	10	5000		
82	431	114	12153	12	28	5000		
82	431	114	12153	12	28	5000		
82	431	114	12153	12	28	7500		
						35000*		
82	431	520	12149	12	28	36043		
						36043*		
82	431	700	12082	12	14	225		
						225*		
82	431	750	12003	12	01	10000		
						10000*		
82	431	810	12112	12	18	7020		
						7020*		
82	431	850	12043	12	07	2475		
						2475*		
							235763	
82	432	841	12151	12	28	179286		
						179286*		
							179286	
								415049

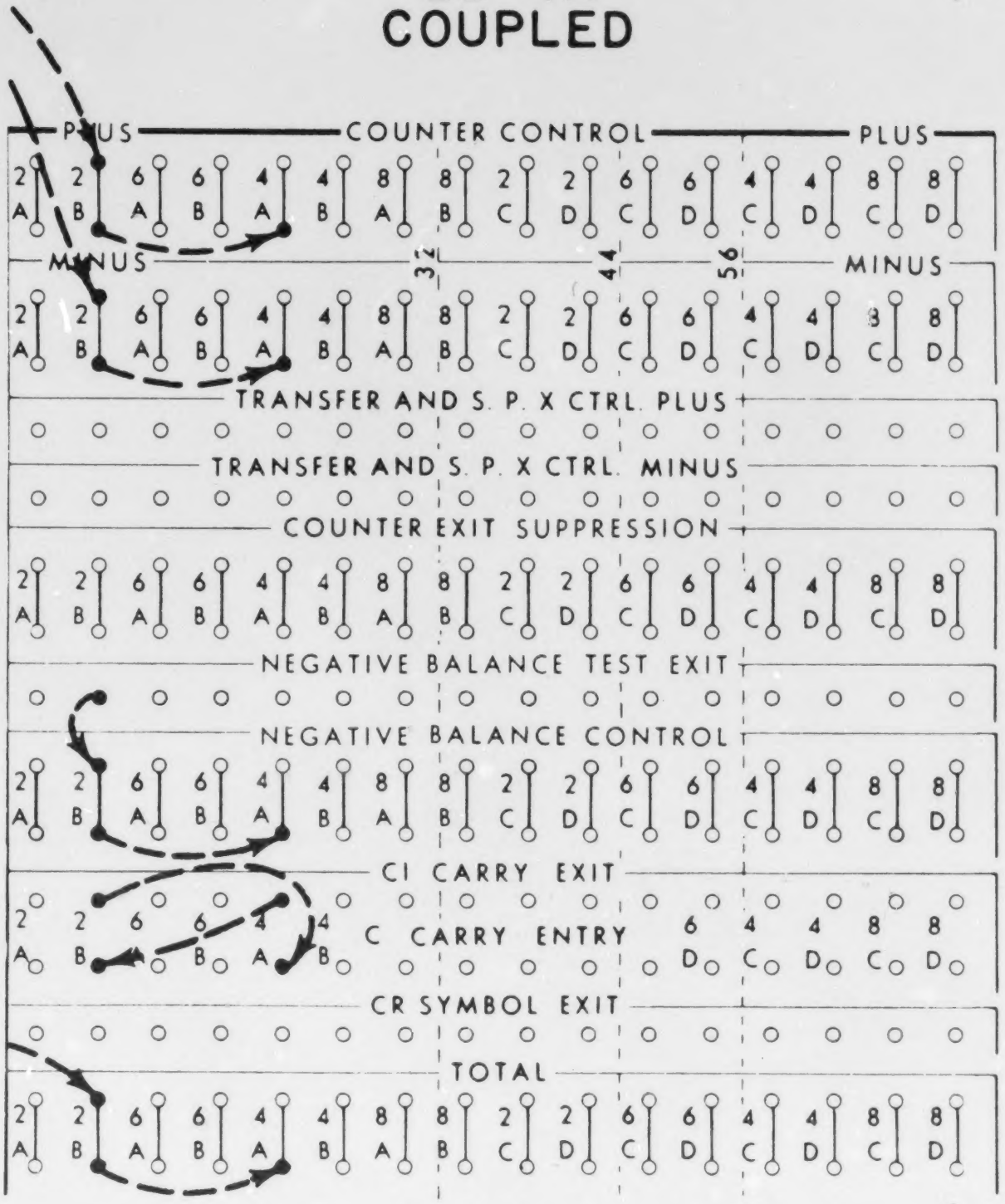
FIGURE 20A. DETAIL PRINTED REPORT

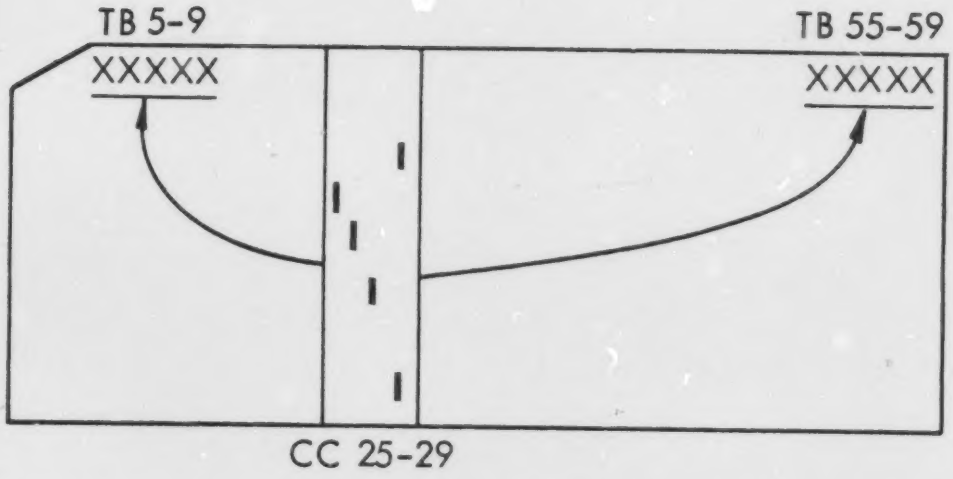
EXPENSE DISTRIBUTION
BY DEPARTMENT OR BRANCH

DEPT. OR BRANCH	ACCOUNT No. GEN. LEDG.	ACCOUNT No. SUB LEDG.	OUR INVOICE NUMBER	DATE MO.	DATE DAY	AMOUNT	AMOUNT BY ACCOUNT	AMOUNT BY DEPT. OR BRANCH
82	431	112				60000		
82	431	113				85000		
82	431	114				35000		
82	431	520				36043		
82	431	700				225		
82	431	750				10000		
82	431	810				7020		
82	431	850				2475		
							235763	
82	432	841				179286		
							179286	
								415049

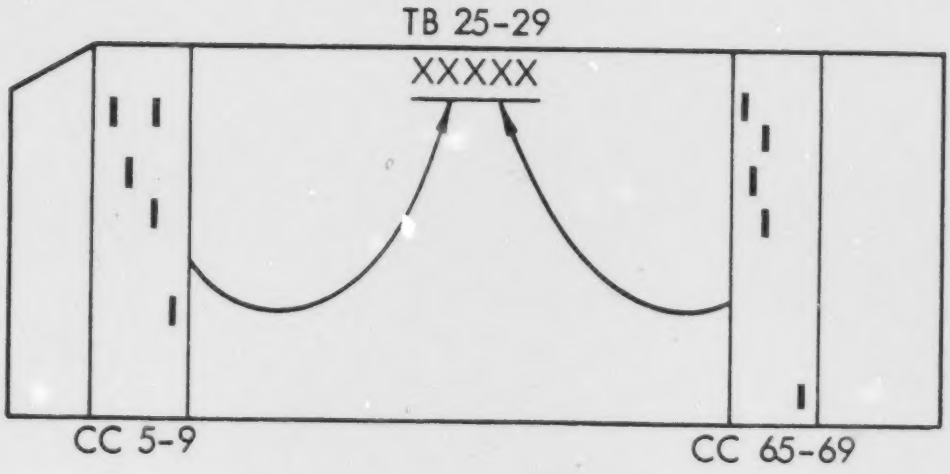
GROUP PRINTED REPORT

2B-4A COUPLED





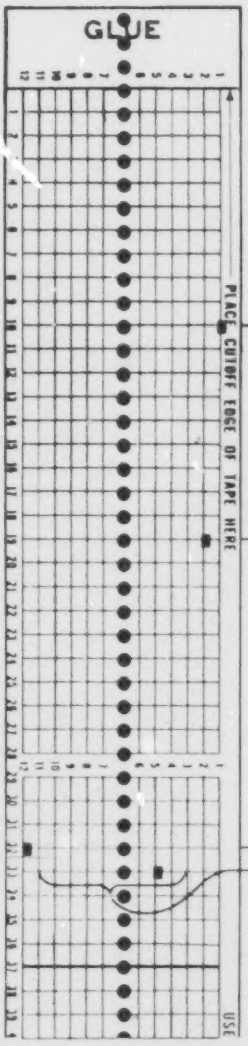
CLASS SELECTION (PRINT CC 25-29 IN EITHER TB 5-9 OR 55-59)



FIELD SELECTION (PRINT CC 5-9) OR CC 65-69)

SELECTOR USE 548

CONTROL TAPE AND SINGLE HEADING FORM



STATEMENT

GENERAL MANUFACTURING CO.

ENDICOTT N Y

IN ACCOUNT WITH

A B SMITH & CO
1025 E MAIN ST
DAYTON OHIO

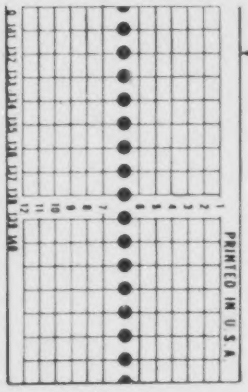
CUSTOMER NO
7756

MO	DAY	YR
5	01	

CODES
1 CASH
2 RETURN
3 ALLOWANCE

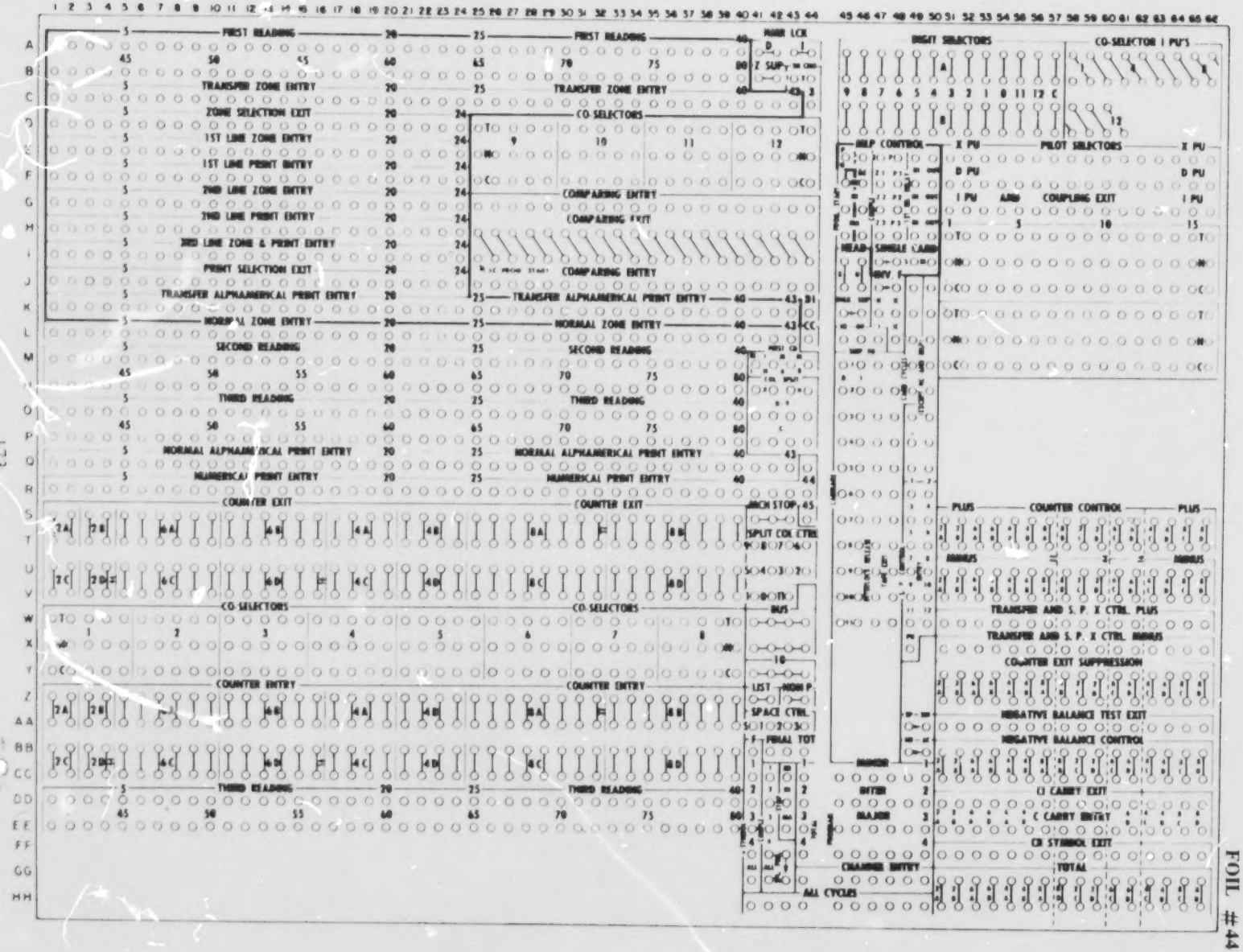
DATE MO	DAY	REFERENCE	CODE	CHARGES	CREDIT
3	12	21046		20650	
4	2	28522		13462	
4	10	5096	1		20650
				BALANCE DUE	13462

1
2
3
4



22" MAXIMUM LENGTH OF FORM

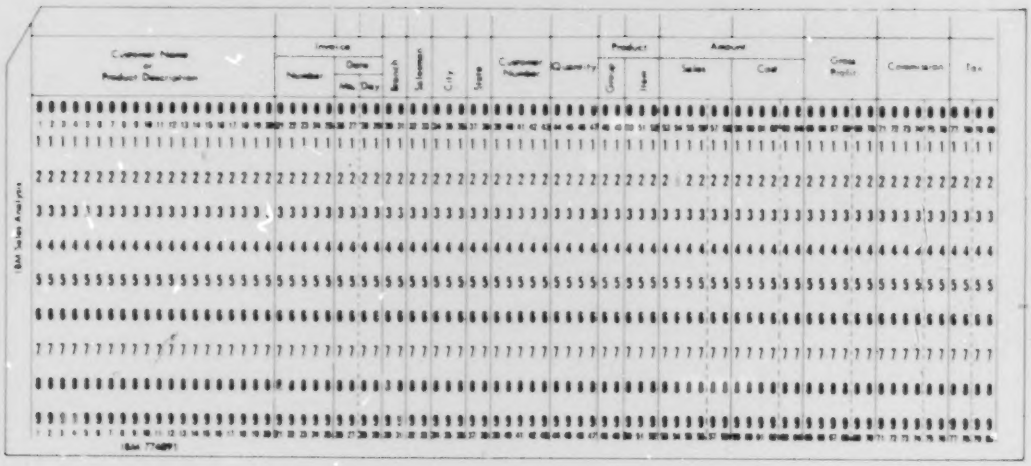
1. Channel 1-First Printing Line Stop.
2. Channel 2-First Body Line Stop.
3. Channel 12-Overflow Start
4. Channels 3 to 11-Normal Stops.

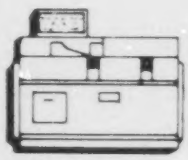
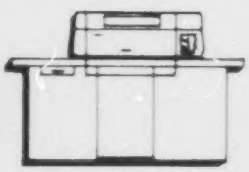
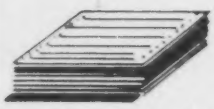

FIRST READING
TRANSFER ZONE ENTRY
ZONE SELECTION EXIT
1ST LINE ZONE ENTRY
1ST LINE PRINT ENTRY
2ND LINE ZONE ENTRY
2ND LINE PRINT ENTRY
3RD LINE ZONE & PRINT ENTRY
PRINT SELECTION EXIT
TRANSFER ALPHAMERICAL PRINT ENTRY
NORMAL ZONE ENTRY
SECOND READING
THIRD READING
NORMAL ALPHAMERICAL PRINT ENTRY
NUMERICAL PRINT ENTRY
CO-SELECTORS
COMPARING ENTRY
COMPARING EXIT
COUNTER EXIT
COUNTER ENTRY
RIGHT SELECTORS
CO-SELECTOR 1 PU'S
HELP CONTROL
PILOT SELECTORS
COUPLING EXIT
COUNTER CONTROL
TRANSFER AND S. P. X CTRL. PLUS
TRANSFER AND S. P. X CTRL. MINUS
COUNTER EXIT SUPPRESSION
NEGATIVE BALANCE TEST EXIT
NEGATIVE BALANCE CONTROL
CI CARRY EXIT
C CARRY ENTRY
CR SYMBOL EXIT
CHANNEL ENTRY
ALL CYCLES
MINOR
INTER
MAJOR
TOTAL

173

FOIL #44

CARD LAYOUT


Customer Name or Product Description
Invoice
Number
Date
Mo. Day
Branch
Salesman
City
State
Customer Number
Quantity
Product
Code
Item
Amount
Sales
Cost
Gross Profit
Commission
Tax

INPUT-OUTPUT DEVICE	RECORDING MEDIA	INFORMATION TRANSFER
Card Reader	80-Column Cards	READ cards → Central Processor
 Card Punch	80-Column Cards	PUNCH cards → Central Processor
 Printer	 Paper Stock	PRINT documents → Central Processor
Magnetic Tape Unit	Magnetic Tape	READ from tape → / WRITE on tape → Central Processor

PERIPHERAL EQUIPMENT AND RECORDING MEDIA

COMPARISON OF NUMBERING SYSTEMS

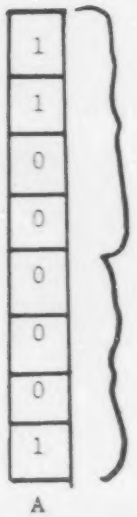
Decimal	Binary	Octal	Hexadecimal
0	0	0	0
1	1	1	1
2	10	2	2
3	11	3	3
4	100	4	4
5	101	5	5
6	110	6	6
7	111	7	7
8	1000	10	8
9	1001	11	9
10	1010	12	A
11	1011	13	B
12	1100	14	C
13	1101	15	D
14	1110	16	E
15	1111	17	F
16	10000	20	10
17	10001	21	11
18	10010	22	12
19	10011	23	13
20	10100	24	14

BCD REPRESENTATION OF DATA
IN MEMORY WITH ODD PARITY

		Ø	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Parity Bits	P	1	0	0	1	0	1	1	0	0	1	0	0	1	0	1	1	0	0	1	1	1	0	1	0	0
Zone Bits	B	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	A	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
	8	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
Numeric Bits	4	0	0	0	0	1	1	1	1	0	0	0	0	0	1	1	1	1	0	0	0	0	0	1	1	1
	2	0	0	1	1	0	0	1	1	0	0	0	1	1	0	0	1	1	0	0	0	1	1	0	0	1
	1	0	1	0	1	0	1	0	1	0	1	1	0	1	0	1	0	1	0	1	1	0	1	0	1	0

		P	Q	R	S	T	U	V	W	X	Y	Z
Parity Bits	P	1	1	0	1	0	1	0	0	1	1	0
Zone Bits	B	1	1	1	0	0	0	0	0	0	0	0
	A	0	0	0	1	1	1	1	1	1	1	1
	8	0	1	1	0	0	0	0	0	0	1	1
Numeric Bits	4	1	0	0	0	0	1	1	1	1	0	0
	2	1	0	0	1	1	0	0	1	1	0	0
	1	1	0	1	0	1	0	1	0	1	0	1

HEXADECIMAL REPRESENTATION



PROCEDURES IN PROGRAMMING

1. DEFINE THE PROBLEM
   A. INPUT/OUTPUT
   B. SCOPE OF THE PROBLEM
2. FLOWCHART
3. CODE SOURCE PROBLEM
4. KEYPUNCH SOURCE DECK
5. ASSEMBLE OR COMPILE
6. DEBUG LANGUAGE ERRORS
7. TEST
8. DEBUG LOGIC ERRORS
9. DOCUMENTATION

FOIL #51

RPG CONTROL CARD AND FILE DESCRIPTION SPECIFICATIONS

IBM International Business Machine Corporation

Program		Punching Instruction	Graphic									Card Electro Number
Programmer	Date		Punch									

Page 01 — Program Identification: SAMPLE

Control Card Specifications

H

Line	Form Type	Core Size to Compile	Object Output	Listing Options	Core Size to Execute	Debug	MFCM Stacking Sequence	Inverted Print	360/20 2540 Buffer	Number Of Print Positions	Alternate Collating Sequence	Model 20: Address to Start	Work Tapes	Overlap Open	Overlap Printer	Binary Search	Tape Error	2152 Checking	Inquiry	Model 20: Read Write Composite	Keyboard Output	Skip Handling	1P Forms Position	Indicator Setting	File Translation	Punch MFCU Zero	Nonprint Characters	Table Load Halt	Stand-Alone I/O	Field Print	Formatted Core Dump	RPG to RPG II Conversion	Refer to the specific System Reference Library manual for actual entries
01	H																																

File Description Specification

F

Line	Form Type	Filename	File Type: I/O/U/C/D	File Designation: P/C/R/T/O	End of File: W	Sequence: A/D	File Format: F/V/S/M/D	Block Length	Record Length	Mode of Processing: L/R	Length of Key Field or of Record Address Field	Record Address Type: A/P/I/N/K	Type of File Organization or Additional Area: I/O/T/or/2	Overflow Indicator	Key Field Starting Location	Extension Code: E/L	Device	Symbolic Device	Labels: S/N/E/M	Name of Label Exit	Extent Exit for DAM	Core Index	File Addition/Unchained: A/U	Number of Tracks for Cylinder Overflow	Number of Extents	Tape Rewind: R/U/N	File Condition: U1-U8
																			Continuation Lines: K	Option	Entry					
02	F	¥																									
03	F	¥																									
04	F	CARDIN	IP		F		80	80									READ20										
05	F	REPORT	O		F		132	132					OF				LPRINTER										
06	F																										
07	F																										
08	F																										
09	F																										
10	F																										
	F																										
	F																										

SAMPLE PROGRAM
AUTHOR JOHN DOE

RPG EXTENSION AND LINE COUNTER SPECIFICATIONS

IBM International Business Machine Corporation

GX21-9091-2 UM/050*
Printed in U.S.A.

Program		Punching Instruction	Graphic		Card Electro Number
Programmer	Date		Punch		

Page 02 of __ Program Identification SAMPLE

Extension Specifications

Line	Form Type	Record Sequence of the Chaining File	Number of the Chaining Field	From Filename	To Filename	Table or Array Name	Number of Entries Per Record	Number of Entries Per Table or Array	Length of Entry	P/B/L/R	Decimal Positions	Sequence (A/D)	Table or Array Name (Alternating Format)	Length of Entry	P/B/L/R	Decimal Positions	Sequence (A/D)	Comments
01	E																	
02	E																	
03	E																	
04	E																	
05	E																	
06	E																	
07	E																	
08	E																	
	E																	
	E																	

Line Counter Specifications

Line	Form Type	Filename	1 Line Number	1 FL or Channel Number	2 Line Number	2 OL or Channel Number	3 Line Number	3 Channel Number	4 Line Number	4 Channel Number	5 Line Number	5 Channel Number	6 Line Number	6 Channel Number	7 Line Number	7 Channel Number	8 Line Number	8 Channel Number	9 Line Number	9 Channel Number	10 Line Number	10 Channel Number	11 Line Number	11 Channel Number	12 Line Number	12 Channel Number
11	L	REPORT	005	01	060	12																				
12	L																									
	L																									

*No. of sheets per pad may vary slightly.

FOIL #52

FOIL #53

RPG INPUT SPECIFICATIONS

IBM International Business Machine Corporation

GX21-9094-2 U/M 050
Printed in U.S.A.

Program	–	Punching Instruction	Graphic								Card Electro Number
Programmer	Date		Punch								

Page 03 of __ Program Identification SAMPLE

Line	Form Type	Filename	Sequence	Number (1-N)	Option (O)	Record Identifying Indicator or *	Record Identification Codes 1: Position	1: Not (N)	1: C/Z/D	1: Character	2: Position	2: Not (N)	2: C/Z/D	2: Character	3: Position	3: Not (N)	3: C/Z/D	3: Character	Number Select	P/B/L/R	Field Location: From	Field Location: To	Decimal Positions	Field Name	Control Level (L1-L9)	Matching Fields or Chaining Fields	Field Record Relation	Field Indicators: Plus	Field Indicators: Minus	Field Indicators: Zero or Blank
01	I	CARDIN	AA			12	78																							
02	I		OR			13	78	NZ																						
03	I																				39	43	0	CUST	L1					
04	I																				62	62	0	CLASS						
05	I																				63	66	0	CLNUM						
06	I																				67	73	2	AMOUNT						
07	I																													
08	I																													
09	I																													
10	I																													
11	I																													
12	I																													
13	I																													
14	I																													
15	I																													
16	I																													
17	I																													
18	I																													
19	I																													
20	I																													
	I																													
	I																													
	I																													
	I																													
	I																													

*No. of forms per pad may vary slightly

182

RPG CALCULATION SPECIFICATIONS

IBM International Business Machine Corporation

GX21-9093-2 UM/050* Printed in U.S.A.
*No. of forms per pad may vary slightly

Program | Punching Instruction: Graphic | Card Electro Number

Programmer | Date | Punch

Page ØA of __ | Program Identification: SAMPLE

C

Line	Form Type	Control Level (L0,L1,...,L9, LR, SR, AN, OR)	Indicators: And	Indicators: And	Factor 1	Operation	Factor 2	Result Field: Name	Result Field: Length	Result Field: Decimal Positions	Half Adjust (H)	Resulting Indicators: Arithmetic: Plus	Minus	Zero	Resulting Indicators: Compare: 1>2	1<2	1=2	Resulting Indicators: Lookup(Factor 2): High	Low	Equal	Comments
01	C		13		SALTOT	ADD	AMOUNT	SALTOT	82												
02	C		12		RETTOT	ADD	AMOUNT	RETTOT	82												
03	C	L1			SALTOT	SUB	RETTOT	NETTOT	92												
04	C																				
05	C																				
06	C																				
07	C																				
08	C																				
09	C																				
10	C																				
11	C																				
12	C																				
13	C																				
14	C																				
15	C																				
16	C																				
17	C																				
18	C																				
19	C																				
20	C																				
	C																				
	C																				
	C																				
	C																				
	C																				

183

FOIL #54

FOIL #55

RPG OUTPUT SPECIFICATIONS

IBM International Business Machine Corporation

GX21-8080-2 U/M 080
Printed in U.S.A.

Program		Punching Instruction	Graphic								Card Electro Number
Programmer	Date		Punch								

Page 05 of __ Program Identification SAMPLE

Line	Form Type	Filename	Type (H/D/T/E)	Stacker # / Fetch(F)	Space Before	Space After	Skip Before	Skip After	Output Indicators And	Output Indicators And	Output Indicators And	Field Name	Edit Codes	B/A/C/1 B/R	End Position in Output Record	P/B/L/R	Constant or Edit Word
			O A N D	R					Not	Not	Not	*AUTO					
01	O	REPORT	H		2	01			1P								
02	O		OR						OF						49		'SALES ANALYSIS BY CUSTOM'
03	O														51		'ER'
04	O														73		'PAGE'
05	O																
06	O											PAGE			78		
07	O																
08	O																
09	O		H		1				1P								
10	O		OR						OF								
11	O														8		'CUSTOMER'
12	O														24		'COMMODITY'
13	O																
14	O																
15	O																
16	O																
17	O																
18	O																
19	O																
20	O																
	O																
	O																
	O																
	O																
	O																

Commas | Zero Balances to Print | No Sign | CR | - | X = Remove Plus Sign; Y = Date Field Edit; Z = Zero Suppress

Commas	Zero Balances to Print	No Sign	CR	-
Yes	Yes	1	A	J
Yes	No	2	B	K
No	Yes	3	C	L
No	No	4	D	M

*No. of forms per pad may vary slightly

RPG OUTPUT SPECIFICATIONS

GX21-9090-2 J/M 060*
Printed in U.S.A.

IBM International Business Machine Corporation

Program		Punching Instruction	Graphic	Card Electro Number
Programmer	Date		Punch	

Page 06 of __ Program Identification SAMPLE

Comm.as	Zero Balances to Print	No Sign	CR	-
Yes	Yes	1	A	J
Yes	No	2	B	K
No	Yes	3	C	L
No	No	4	D	M

X = Remove Plus Sign
Y = Date Field Edit
Z = Zero Suppress

Line	Form Type	Filename	Type (H/D/T/E)	Stacker # / Fetch(F)	Space Before	Space After	Skip Before	Skip After	Output Indicators And	Output Indicators And	Output Indicators Not	Field Name	Edit Codes	B/A/C/1-9/R	End Position in Output Record	P/B/L/R	Constant or Edit Word
01	O		H		2				1P								
02	O		OR						OF								
03	O														7		'NUMBER'
04	O														18		'CLASS'
05	O														26		'NUMBER'
06	O														42		'SALES'
07	O														58		'RETURNS'
08	O														76		'NET SALES'
09	O		D		2				12								
10	O		OR						13								
11	O											CUST.	N		8		
12	O											CLASS	N		18		
13	O											CLNUM	N		26		
14	O								12			AMOUNT			58		' , Ø. '
15	O								13			AMOUNT			42		' , Ø. '
16	O																
17	O																
18	O																
19	O																
20	O																
	O																
	O																
	O																
	O																
	O																

*No. of forms pad may vary slightly

185

49.3

FOIL #56

FOIL #57

RPG OUTPUT SPECIFICATIONS

GX21 9080-2 U/M 050*
Printed in U.S.A.

IBM International Business Machine Corporation

Program		Punching Instruction	Graphic		Card Electro Number
Programmer	Date		Punch		

Page [ ][ ] of [ ] Program Identification [ ][ ][ ][ ][ ][ ][ ][ ]

Commas	Zero Balances to Print	No Sign	CR	-
Yes	Yes	1	A	J
Yes	No	2	B	K
No	Yes	3	C	L
No	No	4	D	M

X = Remove Plus Sign
Y = Date Field Edit
Z = Zero Suppress

Constant or Edit Word

Line	Form Type	Filename	Type (H/D/T/E)	Space/Skip/Fetch(F)	Space Before	Space After	Skip Before	Skip After	Output Indicators And	And	And	Field Name	Edit Codes	B/A/C/1-9/R	End Position in Output Record	-/Z/B/J/R	Constant or Edit Word
01	O		T	2					L1								
02	O														15		'CUSTOMER TOTALS'
03	O											SALTOT		B	42		' , $Ø. '
04	O											RETTOT		B	58		' , $Ø. '
05	O											NETTOT		B	78		' , $Ø. CR'
06	O																
07	O																
08	O																
09	O																
10	O																
11	O																
12	O																
13	O																
14	O																
15	O																
16	O																
17	O																
18	O																
19	O																
20	O																
	O																
	O																
	O																
	O																
	O																
	O																

*No. of forms per pad may vary slightly

DIVISION XXXVIII

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29 Card Punch, A24-3332-3.

RECOMMENDED FILMS

Modern Talking Picture Service, Inc. *Through IBM:*
"A Better World"
"Computer Glossary"
"The Information Machine"
"Information Retrieval"
"Laboratory Automation Based Systems"
"A Little Bit Better"
"Man and the Computer . . . A Perspective"
"Paperwork Explosion"
"Systems"
"Toward Better Government"

Others:

"Automatic Computers" (IBM)
"Automation" (A CBS News "See it Now" McGraw-Hill)
"Automation of B. F. Blurb, Inc." (DPMA International Hdq.)
"Computer Programming" (Systems Development Corporation)
"Data Processing for Hospitals" (IBM)
"Electronic Bank Bookkeeping" (Burroughs Corporation)
Audio-visuals from Office of Education, U. S. Dept. HEW:
"Automation"
"Base and Place"
"Census Sixth"
"Digital Computer Programming—Introduction to PINT for the RPC-4000"
"Digital Computers: Introduction"
"Electronic Computers Improve Management Control"

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